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The Transition of Computing Graduates From Higher Education to Employment

Doctoral thesis

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Norwegian University of Science and Technology
Thesis for the Degree of Philosophiae Doctor
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Abstract

As the demand for computing graduates has increased rapidly in Norway [68], there is a need to explore how we can ensure that all students starting a higher education computing study program graduate and develop employability. Currently, the main focus in the cultivation of employability is how to develop the 'right' competence. This thesis, however, looks at employability from a process perspective, linking employability to identity formation. This gives room for exploring how students align with the computing discipline, if they can imagine their future jobs, and which activities they participate in both at the university and outside of the university.

This PhD project has three aims: The first aim is to provide deeper insight into students' employability development in higher computing education and their transition to employment. The second aim is to enhance the understanding of employability by connecting it to the Community of Practice conceptual framework. The third aim is to contribute knowledge and a new understanding to improve higher computing education. To address these aims, the main research question is: *"What characterizes students' employability development in higher computing education, and what can be done to facilitate employability development in higher computing education?"*

To this end, both qualitative methods and mixed-methods research have been conducted. The study examined employability in the higher computing education research field through interviews and questionnaires with first-year students, alumni, and employers.

The thesis explored how the concept of employability is used in higher computing education in Norway and found that the focus on employability is quite narrow, focusing on students' skills and knowledge during their education. Through using a Community of Practice theoretical framework, where we have placed identity at the center, this thesis argues that employability is closely related to identity formation. Higher computing education could think of employability as an identity-formation process. Then it could be beneficial for students' employability development to include alignment with the discipline, engagement in meaningful activities, and the strengthening of students' ability to imagine their professional futures.

The thesis makes several contributions, both practical and theoretical. One theoretical contribution entails a way of seeing employability as a continuous process that goes beyond higher education. The higher education research field could understand employability not as a final state to be reached at graduation, but rather

as the continuous development of a disciplinary identity. A second theoretical contribution is to use 'modes of identification' as a lens when researching employability as an identification process. By including aspects of modes of identification - alignment, engagement, and imagination - in study programs in higher computing education, students can experience belonging. To ensure that students feel they belong, and form a disciplinary identity, higher computing education institutions should be sure to present societal perspectives, diversity in role models, and potential employers, which can for instance be showcased through guest lectures and projects. This will enable students to prepare for employment from their first study year. The thesis thus also has practical implications: it provides guidelines for how higher computing education can facilitate employability by emphasizing imagination, engagement and alignment, and thus forming a disciplinary identity.

Sammendrag

Behovet for arbeidstakere innen IT har økt hurtig de siste årene. Det er derfor et behov for å undersøke hvordan vi kan sikre at alle studenter som starter ved høyere IT utdannelse, fullfører utdanningen sin og utvikler ansettbarhet (employability). Innen forskning på ansettbarhet er hovedfokuset per dags dato hvordan studenter kan tilegne seg den "rette" kompetansen. Denne avhandlingen ser derimot på ansettbarhet med et prosessperspektiv, som knytter identitetsutvikling til ansettbarhet. Dette gir mulighet til å forske på hvordan studenter tilpasser seg fagfeltet, om de kan forestille seg deres fremtidige jobb i fagfeltet, og hvilke faglige aktiviteter de bør engasjere seg i både på universitetet og utenfor.

Denne avhandlingen har tre mål: det føreste målet er å få større innsikt i hvordan studentenes ansettbarhet utvikler seg, og hvordan overgangen til arbeidslivet er. Det andre målet er å øke forståelsen av ansettbarhet ved å knytte det til rammeverket Communities of Practice. Det tredje målet er å bidra til kunnskap og ny forståelse for å bedre høyere IT utdannelse. For å nå disse målene er hovedforskningsspørsmålet i denne avhandlingen *"Hva karakteriserer studentenes utvikling av ansettbarhet i høyere IT utdannelse, og hva kan gjøres for å tilrettelegge utviklingen av ansettbarhet i høyere IT utdannelse?"*

For å besvare problemstillingen har denne avhandlingen brukt både kvalitative og mixed metoder. Gjennom intervjuer og spørreundersøkelser med førsteårsstudenter, alumni og arbeidsgivere har denne studien utforsket ansettbarhet i høyere IT utdanning.

Avhandlingen har utforsket hvordan konseptet ansettbarhet er brukt i høyere IT utdanning i Norge. Ansettbarhet har hatt et snevert fokus, hvor fokuset har vært knyttet til studentenes kunnskap og ferdigheter i utdanningen. Gjennom å bruke det teoretiske rammeverket Communities of Practice, hvor jeg har plassert identitet i sentrum, argumenterer avhandlingen for at ansettbarhet er tett knyttet til identitetsdannelse. Høyere IT utdanning bør derfor tenke på ansettbarhet som en prosess som utvikler identitet. Det er et behov for å inkludere studentenes tilpassning (alignment) til fagfeltet, engasjement(engagement) i meningsfylte aktiviteter, og styrke studentenes evne til å forestille seg (imagine) deres fremtidige arbeidsliv.

Avhandlingen har flere bidrag, både praktiske og teoretiske. Et teoretisk bidrag er å se på ansettbarhet som en kontinuerlig prosess som strekker seg ut over høyere utdanning. Forskningsfeltet for høyere utdanning bør forstå ansettbarhet som noe mer enn en endelig tilstand som skal oppnås ved uteksaminering, nemlig som en kontinuerlig utvikling av fagspesifikk identitet. Et annet teoretisk bidrag er å bruke "modes of identification" som briller når man undersøker ansettbarhet som

en identitetsdannelsesprosess. Ved å inkludere aspekter fra modes of identification (tilpassningsevne, engasjement, forestillingsevne) i studieprogrammer i høyere utdanning, kan studentene oppleve større tilhørighet. For å sikre at studentene føler tilhørighet, og danner en fagspesifikk identitet, bør institusjoner for høyere utdanning være sikre på å inkludere samfunnsperspektiver, samt forskjellige rollemodeller og potensielle arbeidsgivere gjennom gjesteforelesninger og prosjekter. Dette vil gjøre det mulig for studentene å utvikle ansettbarhet fra første studieår. Avhandlingen har også praktiske implikasjoner: Den gir retningslinjer for hvordan høyere IT utdanning kan legge til rette for ansettbarhet ved å vektlegge det at studentene skal kunne se for seg fremtidig arbeidsliv, være engasjert i nyttige aktiviteter og klare å tilpasse seg til fagfeltet, og dermed danne en fagspesifikk identitet.

Preface

This thesis is submitted to the Norwegian University of Science and Technology (NTNU) in partial fulfillment of the requirements for the degree of Philosophiae Doctor.

The PhD work was performed at the Department of Computer Science, NTNU, Trondheim, under the supervision of Associate Professor Birgit R. Krogstie (main supervisor), Senior Researcher Ingunn Johanne Ness, and Professor Guttorm Sindre (co-supervisors).

During this PhD project, I have been involved in the Excited Center for Excellent IT Education, led by Guttorm Sindre. Excited receives public funding through DIKU, Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education.

A story about a student

There was a student who studied computer engineering. The student had many friends at the study program, did the required homework, and performed as expected. This student developed the skills, knowledge, and personal attributes required to get a computer engineering job. However, when the time came for the student to apply for employment, it was clear that the student did not feel a connection with the discipline and chose not to apply for any job. The student could not identify as a computer engineer and was afraid that these jobs did not match the values and wishes of the student.

This student was me.

Retrospectively, I question whether there is more to employability than just the skills, knowledge and personal attributes suggested by the literature? Could aspects of a students' identity hinder a student from getting employment? If so, then identity is quite important and should be explored in this context.

Acknowledgements

I feel privileged for the opportunity to carry out a PhD project, and I would like to thank everyone who has contributed to my research journey. Without your support, guidance, and love, my PhD journey would have been very hard.

I would like to express my gratitude and thank you's to my supervisors Birgit R. Krogstie, Ingunn Johanne Ness, and Guttorm Sindre. Thank you Birgit for being my main supervisor, both on my master's and PhD thesis, for our discussions, and for showing me the importance of illustrations. Thank you, Ingunn, for your open arms and your positive attitude. And thank you Guttorm for your analytical feedback and experiences. I would also like to thank John Krogstie and Thorleif Hjeltnes for supervising my work early in this project.

I want to thank all my colleagues from the Department of Computer Science, AIT group, and the Excited center. The AIT group has been a part of my life for over ten years now, as I have done my bachelor's, master's, and now PhD here. Thank you for a good social environment in which people care about each other, for all the interesting discussions in the lunch break, as well as the parties and trips we have been on. Thanks to Monica Storvik for being a unifying leader. Thanks to the AIT PhD group, and especially thank you to Ali, Nana, and Emanuel for their energy, motivation, and conversations. For the last four years, I have been a part of the Excited group, and I would like to thank the group for giving me a researcher community. Thanks to the Excited PhD group for discussions and collaborations, and especially thank you to Justyna for reminding me to take care of myself.

Next, I would like to thank my family. Thank you mom and dad for having influenced me to be curious, structured, and believe in me. Thank you to my parents-in-law, Torgunn and Bjørn Olav, for all the dinners, coffee, and discussions. Thank you for all the cat memes Anne Martine, and thank you Mormor for your eternal efforts in trying to understand what I do.

A big thank you to my close PhD friends the last year; Elise Klæbo Vonstad, Madeleine Lorås, and Beate Eltarvåg Gjesdal. Your encouragement, discussions, and faces have made the last year so much easier. To Elise, for your strength, contagious energy, and your support. To Madeleine, for your engagement with our surroundings, your drive, and your help. To Beate, for your hospitality and our good discussions.

To all my friends who have gotten little attention the last year: I'm back! Thank you; To my close friends Ragnhild S. Solberg and Veronica Ski-Berg who inspire me with their PhD journeys and strength; To Margaret Crocket for keeping me

grounded in real life; To Boye for sharing your knowledge, and for the discussions of tools together with André and Tor Ivar; To Kim for all the funny memes; To Ingolf, Ola, and Kjersti for always being there; To Karoline for our conversations.

A big thank you to my husband Erlend for being there through all my ups and downs. Thank you for knowing what I need when I do not know it myself. Thank you for being patient, for believing in me, and for listening to all my rants. You have made the PhD journey more enjoyable.

Lastly, I want to thank myself for breaking my own boundaries and continuing even through hard times.

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Part I

Synopsis

Chapter 1

Introduction

As the use of technology continues to grow, the demand for computer graduates is increasing [22, 27, 68]. One of the main goals for higher education is to educate students so that they can get a job that benefits society. In order to do this, higher education could meet the competency demand from the labor market, as this is crucial for society's ability to adapt and change with the future [46]. The need for educating computer graduates is increasing, and the gap between the labor demand and the number of educated graduates continuous to grow [22, 27]. There is thus a need for higher education, and especially higher computing education, to ensure that all educated computer graduates are employable and have high employability.

The term 'employability' is used to explain how employable a person is. However, employability is a term with many definitions, and there is no general agreement on what makes someone employable [82]. Within research, the most common understanding of employability is to consider it as a question of competence [36, 39]. This perspective is often used in the evaluation of students' skills, knowledge, and personal attributes in a hiring setting, to figure out if they are competent enough for an employer [95]. This PhD project viewed employability as a possession of competence in the beginning. However, it may be argued this view of employability is too narrow and neglects the complexity of employability [39]. The PhD project changed its employability perspective to a processual view later in the project (see section 6.2.4 for elaboration), considering employability as something that develops over time [36]. When employability is seen as a process, it can be considered as closely connected to identity formation [36] and can be re-defined as Pre-Professional Identity (PPI) [39].

Higher education can be considered as a social learning setting. In this thesis the

social theory of Communities of Practice (CoP) [49, 89] is applied as the conceptual framework due to how CoP focuses on participation in social communities, learning their practices, and forming identities in relation to these communities [89, p 4]. Learning can change who we are and who we want to become. In the landscape of higher education, identity formation is an ongoing process as students transform to become an *"employable graduate who is ready to transition into an entry-level professional role"* [39, p 3]. Thus, this is a *process of becoming*. Studying participation and learner trajectories makes it possible to look into becoming as a *"holistic process that includes social relations and emotions"* [64, p 150]. In Higher Computing Education (HCE), computer graduate identity has been defined as *"the transformation of one's interest in computing into seeing one's self as a person who does computing and self-identifies with one or more computing subdisciplines and career paths"* [43, p 192]. This includes engaging in the practices and participating in the communities of the discipline.

When looking at learning as identity formation, and participation in communities as important for this formation, we see that employability is closely linked to identity formation as well, which makes room for including other considerations besides just competence for employability – e.g., the feeling of belonging. In this thesis "modes of identification" [91] (previously known as "modes of belonging" [89]) are concepts that are helpful in shedding light on employability development as a social process. When we understand how students' employability is developing, it is also possible to understand how students' employability can be improved in higher computing education. Thus, the overarching research question in this thesis is:

> *What characterizes students' employability development in higher computing education, and what can be done to facilitate employability development in higher computing education?*

To answer the main question, we have several research questions:

> RQ1: *How can the concept of employability be enriched by a perspective focusing on modes of identification?*
>
> RQ2: *Which factors influence students' employability development?*
>
> RQ3: *What can higher computing education do to facilitate students' employability development?*

The aim of this thesis is to provide deeper insight into students' employability development in higher computing education and their transition to employment.

The second aim is to enhance the understanding of employability by connecting it to the CoP conceptual framework. The third aim is to contribute knowledge and a new understanding in order to improve higher computing education.

1.1 Research approach

This thesis is positioned within a pragmatic view of reality, combined with social constructivism and concepts from the theory of Community of Practice, to consider the complex and rich material. Social constructivism overlaps with the theory of Communities of Practice in having a social focus and viewing knowledge as a product of social interactions. Adopting social constructivism and the concept of Community of Practice in combination with pragmatism provides a strong and rich theoretical framework in tune with the complex socio-technical domains of higher computing education.

Pragmatism is open to different philosophical positions and agrees that research always occurs in a context, e.g., a social setting. As pragmatism accepts that there are multiple realities, the focus is on solving practical problems [96, p 8]. I have chosen to use mixed methods in this thesis, as a mixed-methods approach allows researchers to employ a methodological mix of qualitative and quantitative research approaches that can be tailored to the research questions [41, p 17]. This will be elaborated in section 4.

I have primarily used interviews to collect data, in addition to questionnaires. The thesis builds on empirical data from interviews with students, alumni, employees, and employers (see table 1.1 for the link between papers and informants). Some students participated in a follow-up interview as well. The questionnaires were used to get a more coherent result from the interviews in paper 2, and to get broader data collection in paper 3. Data analysis, transcriptions, coding, and the thematic analysis of the interviews were done in NVivo. The questionnaires were both added to NVivo for the descriptive part, as well as SPSS used for the categorical and continuous variables. The project has been approved by NSD[1] and has followed the ethical guidelines suggested by them.

The research was conducted in a computer science department at a Norwegian university. Close collaboration with study program leaders made it easier to get access to students and alumni. This collaboration had practical implications resulting from the research site being easily accessible and applicable to the study program leaders.

[1] Norwegian centre for research data (Norsk Senter for Forskningsdata), which ensures that data about people and society can be collected, processed, stored and shared safely and legally

1.2 Results and contributions

CONTRIBUTIONS:

C1: *Contributed to the employability research field by a deeper conceptualization of employability, achieved by using modes of identification as a lens.*

C2: *Contributed to the employability research field by emphasizing how employability is a process that is ongoing from students' first year of higher education and continues after employment.*

C3: *Contributed to the higher computing education research field in the form of practical guidelines for teachers and educational leaders on how higher computing education can emphasize students' development of employability.*

PAPERS:

P1: Gunhild Lundberg, André Gaustad, Birgit Krogstie. *"The Employer Perspective on Employability"* 2018 IEEE Global Engineering Education Conference (EDUCON) (pp. 909-917). (2018) IEEE.

P2: Gunhild Lundberg, Leif Erik Opland. *"Perceived Employability in Online Education"* Vol 27 No 1 (2019): Proceedings from the annual NOKOBIT conference held in Narvik 26-27 November 2019

P3: Gunhild Lundberg, Birgit Krogstie, John Krogstie. *"From Employable to Fully Operational: The Need for Training of Computer Science Graduates"* International Journal of Engineering Pedagogy (iJEP) 2021

P4: Gunhild Lundberg, Ingunn Johanne Ness. *"Students' Imagination of Future Employment – Identity as an Important Employability Aspect"* In Proceedings of the 9th Computer Science Education Research Conference (CSERC '20) ACM

P5: Gunhild Lundberg, Birgit R. Krogstie *"Employability Through Imagination, Alignment, and Engagement - Students' Prospects and Change During Their First Year in Computing Education"* Koli Calling '20: 20th Koli Calling International Conference on Computing Education Research. ACM

P6: Gunhild Lundberg, Birgit R. Krogstie, Guttorm Sindre *Understanding Employability Through an Identity Formation Perspective - Implications for Higher Computing Education* In review to Journal of Industry and Higher Education, July 2021.

To summarize the papers, see table 1.1. Here, the research questions from each paper are stated. Further, their data collection design and sample are stated, where papers 2 and 3 used a mixed-methods approach. Then, the number of informants

or respondents is stated, as well as the data analysis method used. At the end, each paper's contributions to the different research questions are stated.

1.3 Key concepts

Some of the frequently used terms in this thesis have multiple meanings in research and everyday language. In the thesis, they are to be understood in the following way:

Competency: Generally, when referring to competency this thesis use the definition by Frezza et al. [29, p 171], who defined competency as *"the personal qualities causally related to effective performance in an area of work"* and encompassing three components: knowledge, skills, and dispositions in a professional context. However, this understanding of competence changes when seeing employability as identity formation. Competence development is then understood as participation in communities of practice [89].

Computing Education: Computing is a discipline which consists of *"five defined sub-disciplines: computer science, computer engineering, software engineering, information systems and information technology"* [1]. If not specified otherwise in the articles, the terms "IT," "Informatics," "Computer Science" and "Computing" are used interchangeably, as we use the term IT or ICT (Information and communication technology) as an umbrella for all kinds of computing education in Norway.

Employability: Employability is seen as an identity formation process, which is negotiated in social interactions.

Identity: This thesis uses a negotiation approach to identity [65]. Identity is an experience that is ongoing, is formed through social interaction and participation in communities, is formed by the past and the present, and combines multiple forms of membership and communities [89]. Identity is a process for identification where *"the practice, the community, and one's relationship with it become part of one's identity"* [90, p 3]. He writes further that "[Identity is a] *way of talking about how learning changes who we are and creates personal histories of becoming in the context of our communities"* [89, p 5].

Industry: For simplicity, we use the term "industry" to refer to employers in commercial businesses, the public sector and NGOs. In the university context where this research has been conducted, 'industry' is often used as a collective term encompassing all possible jobs students might have after graduation, except the university itself.

Paper	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5	Paper 6
Paper RQ	How is Employability of graduates perceived by employers, what skills and personal qualities do students need to get employed, and what do these qualities result from?	Does perceived employability (PE) increase during education? Is there a difference between students with and without job experience?	Do employers hire graduates who lack knowledge, and are students fulfilling the requirements from the industry? How much time do companies use for training graduates?	How do first-year students imagine their future job? From whom do students get the understanding of jobs they qualify for?	How can modes of identification be used to explore students' employability process?	How can educational leaders in higher computing education facilitate students' employability development?
Design	Qualitative interview design	Exploratory design (QUAL ->QUAN)	Exploratory design (QUAL ->QUAN)	Qualitative interview design	Qualitative interview design	Review of findings from paper 1-5
Sample	Employer	Alumni	Employees and employers	Students	Students	
Data	10 interviews	7 interviews, questionnaire: 36/93 resp.	6 interviews, questionnaire: 10 resp.	8 interviews	8 interviews, 6 follow-up interviews	5 papers
Analysis	Qualitative content analysis	Qualitative content analysis, Descriptive statistics, categorical and continuous variables	Qualitative content analysis, Descriptive statistics	Qualitative content analysis	Qualitative content analysis	Modes of identification lens on findings from paper 1-5
RQ	RQ3	RQ2, RQ3	RQ1, RQ2, RQ3	RQ1, RQ2, RQ3	RQ1, RQ2, RQ3	RQ1, RQ2, RQ3
C	C3	C2, C3	C1, C2, C3	C1, C2, C3	C1, C2, C3	C1, C2, C3

Table 1.1: Overview of papers, their RQs, and data collection and analysis

1.4 Structure of thesis

Chapter 2: Presents related work within higher education research on employability internationally and in Norway.

Chapter 3: Presents the theoretical grounding. It elaborates on communities of practice, and modes of identification.

Chapter 4: This section describes the philosophical positioning of the thesis, the research design and the research procedure.

Chapter 5: Presents the papers written in this project and their connection to the research questions and their main findings. After presenting each paper, a summary of the main findings are presented.

Chapter 6: Answers the research questions and presents the contributions. It suggests practical and theoretical implications, before evaluating the research and stating its limitations.

Chapter 7: Conclusion and further work of the thesis is stated.

Chapter 2

Employability

This chapter will review and describe related work within employability. Section 2.1 will define employability. Section 2.2 will focus on reviewing employability research in higher education generally before moving to higher computing education in Norway.

The review has been done using the snowball method, as well as using keywords such as "Employability," "Computing Education" or "Graduate Employability" when searching on Google Scholar.

2.1 What is employability?

This section will present different ways of looking at and defining employability, both in terms of which level to focus on and in terms of different perspectives.

In addition to the complexity of the employability concept, there is a disagreement on which term to use when discussing employability-related research. Terms like "work readiness," "career readiness," "transferable skills," or "graduate skills" are sometimes used instead of, or in addition to, employability. In this thesis, we have chosen to use the term employability.

As mentioned, there are many different definitions of employability. How it is understood depends on the perspective taken; it can be dependent on *"time and context, different purposes, interventions, target groups, measures, and activities"* [82, p 168]. Thijssen et al. [82] refeer to Versloot et al. [86] who state that the last three decades have provided three different perspectives on employability: 1. The society, 2. The company, and 3. The individual worker. These perspectives are referred to as *levels* by Holmes [36] who distinguishes between the macro-,

meso-, and micro-levels. The macro-level includes institutions, government and their agencies, which are more concerned with the economic and higher education systems, as well as the social benefits of employability. The second level is meso-level; here are persons or agencies that move between the micro and macro levels, for example, subject disciplines or support systems across institutions. The last level is the micro-level; here we find students who are concerned with finding a good job, employers worried about hiring the right students, and teachers concerned with making sure that students are well-prepared for a future job [36]. McQuaid and Lindsay [54] however, had another way of looking at these three levels. First, they point to individual factors – health, demography, skills and attributes, adaptability, and mobility. The second level denotes personal circumstances – which relates to work culture, access to resources, and household circumstances. The third level is the external factors, which is the demand in the employment market, and enabling support factors like, e.g., kindergarten or health care [54].

The distinctions between levels clarify which issues of concern we are looking at, as each level highlights different issues [36]. Thijssen et al. [82], Holmes [36], and McQuaid and Lindsay [54] describe a macro level which includes the society, government, or external factors. Also, when researching employability within one country, many external factors are similar for the inhabitants (e.g., support factors, health care, higher education system, or social benefits). This level is hard to change for students or study program leaders, and the macro perspective will therefore not be used in this PhD project. When it comes to the meso-level, there is little agreement between Thijssen et al. [82] and Holmes [36] on what the level entails. Thijssen et al. [82] explain it as a company perspective while Holmes [36] argues that this level includes agencies that move between the levels. This thesis will not use the meso-level, as there is no agreement on what this level includes. The last level is the micro-level, on which there is some consensus between [82, 36, 54], in terms of focusing on the individual (the worker, the student, the teacher) and personal and individual factors. As this thesis is researching the transition from higher education to employment, I have chosen to use the micro perspective [36], where students, employees, or employers are in focus. However, it is also important to emphasize the factor of the university and those related to the university setting when researching employability, as the university should provide opportunities for students to develop skills for short-term employment, have professional readiness, and be equipped with skills for life-long employability [11].

Even though there is some consensus over the *levels* of employability, there are three different *perspectives* on employability. The first perspective is stated by Holmes [36] as the most dominant perspective on employability, and this interpretation sees employability as something an individual can *possess*. This is often

related to the individual's skills and attributes. Yorke [95] defined employability within this perspective as *"a set of achievements – skills, understandings and personal attributes – that makes graduates more likely to gain employment and be successful in their chosen occupations"* [95, p 8]. This could be closely linked to the competence term, as it is described by Frezza et al. [29, p 166]: *"the personal qualities causally related to effective performance in an area of work"*. In this research, competence consists of three components: knowledge, skills, and dispositions [29]. Holmes [36] argues that this way of seeing employability is deeply flawed as the job interview setting cannot measure whether the candidate is in fact in possession of the skills. Furthermore, there is little agreement on which skills are needed to get a job, and if the skills emphasized by the university actually enable students to get their desired job [36]. The possession view of employability has also been criticized for overlooking individual influences on employability, such as social and cultural capital and identity [11, 83].

The second perspective is to view employability as the *position* an individual has in society. The idea is that students graduating from elite universities get a job based on their social status or position [36]. This perspective might be more relevant for a prestige-based society and a system where the fortunate and less fortunate students do not have the same possibilities for higher education. Education is free for all in Norway, and everyone could in principle qualify for the same education regardless of their background. However, Norway do have less fortunate areas as well. According to Harvey and Reyes [33] students with low social-cultural or -economic backgrounds do not participate in activities outside of university hours, as they might have to work or prioritize being a caregiver while attending university. Universities should be aware of this challenges when planning employability development opportunities. However, this is not the topic for this thesis, this perspective will not be used.

The third approach to employability is to view it as a *process* where the focus is on graduate identity. Here, identity does not refer to an existent entity, but to the *"emergent outcome of situated social processes of identification [. . .] by the individual themselves and by significant others in the social setting"* [36, p 549]. It is in the social settings between a student and e.g. his/her peers, teacher, or employers the identification happens. Relating identity to employability is essential to get a hold of the *"concepts and narratives students have about themselves, their chosen profession and career, and their broader lives"* [11, p 469]. Jackson [39] re-conceptualized employability to *pre-professional identity*, where she argued that this relates to *"an understanding of and connection with the skills, qualities, conduct, culture and ideology of a student's intended profession"* [39, p 2]. Having an identity view on employability connects career path and self-identity to a dis-

cipline: *"the transformation of one's interest in computing into seeing one's self as a person who does computing and self-identifies with one or more computing sub-disciplines and career path"* [43, p 192]. The perspective gives room for exploring students' prospects, narratives, and understanding of their context, which the possession and position perspectives do not emphasize. Seeing employability as identity formation allows students to connect their experience with their future job and make them aware of how their identity connects with where they want to work [35]. In this thesis, an identity view will be used as we focus on *students'* development of employability. This view relates employability to students' intended profession and in which the narratives that students have of themselves are included.

Relating employability to identity formation makes it essential to look into what influences students' identity formation. Smith et al. [76] found that courses, employability development possibilities in the higher education institutions, and life experiences inside and outside of the university affect students' identity work [76]. Practice and self-identification with the discipline are also important when talking about identity: *"Identities are constructed through practice—practice that requires knowledge, skills, and ways of thinking that characterise the discipline in which one is engaging"* [13, p 41].

The concept of *perceived employability* (PE) [7, 40] focuses on continuous employability development, as PE is tightly connected with how an individual sees their own possibilities of getting new employment [7]. PE considers employability as a psycho-social construct, having a person-centered focus and approach [30]. PE places more emphasis on contextual factors compared to the possession approach to employability [85]. Having a high degree of PE indicates that employees believe they perform well in their job, and it is associated with lower levels of job exhaustion, psychological symptoms, and is generally important for employees' well-being [7, 44].

In this thesis, I will take the process perspective on employability, with a strong connection to identity formation. Section 2.2 elaborates on the related work of employability in higher education in Norway. Then, section 3.2 will present Communities of Practice as a theoretical framework to understand human learning and activities, focusing on the identity component and modes of identification.

2.2 Employability in Higher Education

This section briefly reviews the employability research in higher education and higher computing education. It starts with reviewing employability generally to illuminate the central considerations in employability research, before moving to

employability research related to higher computing education in Norway.

2.2.1 Employability in higher education

Internationally, there has been a discussion on when and whether higher education should facilitate employability. McCowan [53] states that *"unfortunately, the simple fact that university comes chronologically before the primary phase of full-time employment leads people to the belief that it is the major or even the only influence on employability"* [53, p 278]. This statement indicates that universities should not have the sole responsibility for students' employability. Moore and Morton [56] argues that the often mentioned skill gap between university and industry is a myth, as every company is unique and needs differently tailored students. It is important to universities not to give the industry too much authority and expertise when discussing curricula. Graduates can only learn to be job-ready in the job they undertake after their studies. However, Brunhaver et al. [12] argues that there is a gap, especially when considering professional knowledge and skills in a technological context. They point out that this gap can be closed by close collaboration between industry and university, by agreeing on expectations for graduates, and what the industry and university roles and responsibilities should be. Mullen et al. [57] argues that employability should be emphasized by universities from students first year: *"Becoming employable is an iterative process which can and often does start in first year"* [57, p 196].

Educational structure and specializations might influence students' employability. In the Bologna Process, the goal was to make European countries align their educational structure to three-year bachelor and two-year master studies. For many countries, this implied large changes. In Norway, the new educational structure was not significantly different from the old one [4, 79]. In Europe, research on how this change in educational structure affected students' employability was initiated, and in Norway, Støren et al. [79] found that graduates from bachelor programs in universities were less employable than college bachelors [79]. The colleges have traditionally been more vocational-oriented, and the study suggests making university bachelors more vocational as well [79]. In later years, the tendency in Norway has been that students choose specialized education (business, computer technology, and electronics, and public-sector education like teaching, welfare, and sport) over generic education [58]. Graduates from specialized education are more employable since specialized competence is more sought after in the employment market [58]. In general, there is a relatively low unemployment rate in Norway (3,9% were unemployed in 2018) [17].

Employability is not only developed in higher education; it continues to be important after the candidate has entered the employment market. Kalleberg and

Rognes [42] identified a set of employment resources considered important for employability: education, seniority in the company, experience in other organizations, skills, a supervisory position, occupational status and prestige, and full-time employment. Employees having more employment resources are more likely to be more committed to their organization, more satisfied, and less likely to leave [42]. Job skills are important for maintaining employment, while getting competence support from employers is essential for career advancement [25]. People who have increased employability are less concerned about having job security and are more likely to have temporary jobs [6]. Nerland and Jensen [59] argue that participating in expert communities and engaging in community alignment is important to finish expected tasks at work. The communities can be both online; as web pages, newsgroups, or chat- and help forums, or in the workplace; knowing whom to ask and how to get your task done [59].

Norway has often been included in studies that compare employability between countries. In some of these studies, Norway stands out from the other countries. One study found that Norwegian graduates tend to assess their education as more useful compared to graduates in other countries [79], while another found that graduates studying abroad tend to move back home when they are from Norway or Iceland [92]. In the OECD countries, Norway had one of the best employment rates in 2016 with 89% for higher education graduates and one of the lowest unemployment rates with 3% for higher education graduates [60].

When looking into what makes a graduate employable, the most dominant view on employability in higher education research has been the possession view with its focus on identifying which skills or knowledge higher education should emphasize to ensure that students become employed after graduation. The most common skills, knowledge, and personal attributes mentioned in higher education research are related to communication, problem-solving, and teamwork [14, 32, 37, 38, 67, 71, 26]. Also, life-long learning, adaptability, and different (intra-)personal qualities are frequently mentioned [28, 32, 38, 71].

2.2.2 Employability in Norwegian higher computing education

In employability research in Norway, the government has been a significant participant. The research initiated by the government uses a possession approach when researching employability and is concerned with the macro level, focusing on the society or institutions. They have initiated several reports in the later years about the employment situation in Norway. One report which looked at the need for future competence stated that there is a lack of workers within software and application development, as well as a lack of system analysts and system architects, [45, 68]. Research in southern Norway found that 78% of IT students get a

job after sending ten or fewer applications, including the 26% that got jobs without applying at all [9]. Graduates within the field of ICT tend to get jobs within the ICT industry, but also within the public sector, offshore, and knowledge-intensive service management jobs [80]. Støren and Nesje [78] found that graduates within ICT had a surprisingly high unemployment rate, even though IT workers were sought after in the employment market. They found that this rate was related to where the graduates lived. In the capital of Norway, the unemployment rate was low, while outside of the capital, the situation was different [78]. Others questioned if the relatively high unemployment rate might be due to the fact that we educate graduates without the desired specializations [45]. A report that analyzes the future demand for competence in Norway pointed out that there are many professions within the field of ICT. The unemployed candidates and those who are in demand in the labor market are not the same people; they have different competence [68]. Actually, in 2018 the lack of ICT workers was twice as high as the unemployment rate in the same field, and the demand for ICT workers has increased rapidly in the last two years [68]. Because of this increasing demand and lack of ICT workers, there is a need to ensure that all students interested in computing graduate with sufficient employability to become employed.

Employability research within higher computing education in Norway has been on a few researchers' agenda. Lauvås and Raaen [48] researched what employers are looking for when hiring a recently graduated computer programmer. They found that teamwork and cultural fit, as well as enthusiasm and curiosity, were most important when graduates apply for a job [48]. On the other hand, Stålhane et al. [77] argued that even though human traits often seem more important than technical skills, technical skills should not be neglected. They found that employers want recently graduated software developers to be good in technical skills such as software development, hands-on experience, adaptability, and client relationships [77]. This hands-on experience could be achieved for instance through having a summer job. Hobby projects and teaching assistant jobs affect students' prospects of gaining a summer job, which they typically do after their third year as IT students [93]. Activities outside of the university can also impact students' development of employability [16]. When employers hire, it is still the traditional methods like interview, requiring a resumé and cover letter, diplomas, and transcripts from the applicant that are most in use. However, the candidates' use of online tools also seem to be of importance. Here the employers look for an online presence to find personality traits, interests, and technical skills if the applicant has a GitHub or StackOverflow page [66]. It is also worth mentioning that small and large companies in Norway evaluate graduates' employability differently. Large companies consider academic achievement first, before looking into the candidate's personal qualities. Small companies first evaluate if the candidate is socially suitable before

looking into their technical skills and knowledge [48].

When employers of computer graduates in Norway were asked which future competence they sought when hiring new graduates, their answers included IT security, cloud services, big data/data analysis, and artificial intelligence [80]. This was overlapping with what most students perceive they have competence within [80]. Compared to students from other science and technical study programs, students from ICT educations are more happy with the work-life relevance of their education [78]. However, there is a need for closer collaboration and connection between higher educational institutions and the industry to make the transition from studies to work easier. Also, the quality and the work relevance in the study programs should be improved [68].

As presented in this section, there are different ways to look at employability. This thesis will focus on the micro-level with a processual view of employability, which is closely related to identity. We have seen that the employability research in Norway primarily focuses on competence, the government being concerned about future demand for competence and how the employment situation in Norway is today, while researchers are more concerned with which skills graduates need to be employed, and if higher education institutions are providing these skills. This thesis will bring new insight into the employability discussion by seeing employability as identity formation.

Chapter 3

Theoretical Grounding

3.1 Employability understood in light of Communities of Practice

There are many ways to look at employability and its levels. This PhD project uses what Holmes [36] calls the micro-level. This means that I am focusing on students who are worried about finding a job, employers concerned with recruiting graduates, and universities teaching and educating students to become employable.

Jackson [39] explains one connection between employability and Communities of Practice (CoP): *"Drawing on the CoP model, reflection, reconciliation, imagination and visualisation will assist individuals in construction PPI* [Pre-Professional Identity] *during their learning journey at university. This identity will assist them in demonstrating preparedness for employment and successfully applying their acquired skills and knowledge in the graduate labour market as a novice professional"* [39, p 18]. Wenger [89] points out that *"[E]ducation must strive to open new dimensions for the negotiation of the self. It places students on an outbound trajectory toward a broad field of possible identities. Education is not merely formative – it is transformative"* [89, p 263]. This thesis will use a Community of Practice framework to look into what will make students employable.

Before explaining about students and their communities in a university setting, it is necessary to stress that the use of the term 'community' here might not correspond to all definitions of the concept of a Community of Practice. Communities in this thesis are based on Wenger [89] definition of communities of practice, where a community should have a shared repertoire, a joint enterprise, and a mutual engagement. The students in this thesis talk about these communities in their

interviews in a way that makes clear that they are essential reference points for the students and are a foundation of their identity.

The discipline community is a community for all people in the same discipline. This community has many different forms of participants, e.g., people who work in the discipline, people who have the discipline as a hobby, and students who work towards gaining competence and seeing themselves as future workers. For simplification, we generalize all computing specializations into one discipline community. We make this generalization based on two points; 1. most of the students from the study programs researched could apply and qualify for the same jobs, even though some students qualify for slightly different jobs; 2. the students participate in and becomes employed in the same work market, namely a small IT industry market in Norway.

Students might have started to become a member of the discipline community before attending higher education. However, during higher education, they get (more) familiar with the repertoire, understand what counts as competence, and how to engage in and align with the discipline, and imagine themselves working in the discipline in the future. When drawing this in a computing setting, a student might be involved in the community before entering higher computing education, e.g., through being an active online member in a computing community.

The discipline community is not the only essential community for a student. While a student attends university, he/she can attend several different communities, e.g., a community held by participants of a study program, or a community based on a student group defined by year, place of study, interests, or teammates, and in addition several communities outside of the university setting. Some of these communities might continue after graduation (e.g., a community based on interests).

When transitioning from being a student to becoming an employee, the student proposes his/hers discipline identity. The employer can affirm this proposed identity, acknowledging that the student has the desired repertoire, engagement, and alignment needed to be considered competent in the discipline. When hired, the student needs to become a member of different company communities. The students are moving from many communities related to their role as students to new communities related to their role as an employee.

When applying for a job and hopefully becoming an employee, students usually continue within the same discipline. An example can be a student attending a computer engineering study program, which relates to the computing discipline. Even though the student can leave many of the communities related to the university when getting a job, they seldom leave the discipline community.

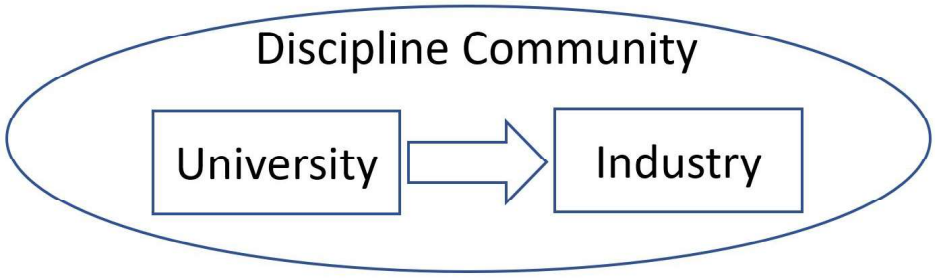

Figure 3.1: Illustrate student transition from Higher Education to Employment within the same discipline community

When looking at employability in light of Communities of Practice, we fundamentally look at students' transition from university to industry within the same discipline (see figure 3.1). This thesis focus on the computing discipline, and the figure illustrates moving from being a student in the computing discipline to becoming a worker within the same computing discipline. Universities can consist of several different discipline communities, where the transition from being a student to becoming an employee can be more challenging in some discipline communities.

3.2 Communities of Practice

This thesis is anchored in a higher computing educational context, with the learner in focus. The learners, or the graduates, develop through their university years, and Peters [62] argue that *"social identity theory has proved itself fruitful as a method to reason about learner development"* [62, p 42]. However, learner development happens also outside of formal education, where Tajfel and Turner [81] explains that a person's sense of who they are depends on groups they belong to. Participating and being a member in a community gives the formation of identity a fundamentally social character [89, p 163].

As we are in an educational setting, where the learners are in focus, and they are dependent on the groups they belong to, it is constructive to apply Communities of Practice (CoP) as the social identity theory perspective [49]. The theory is a social learning theory, which has five pillars closely interconnected to each other: learning, community, identity, meaning, and practice [89]. Wenger places learning at the center (see figure 3.2), and explains the pillars through learning [89, p 5]:

1. *"Meaning: a way of talking about our (changing) ability, individually and collectively, to experience our life and the world as meaningful.*

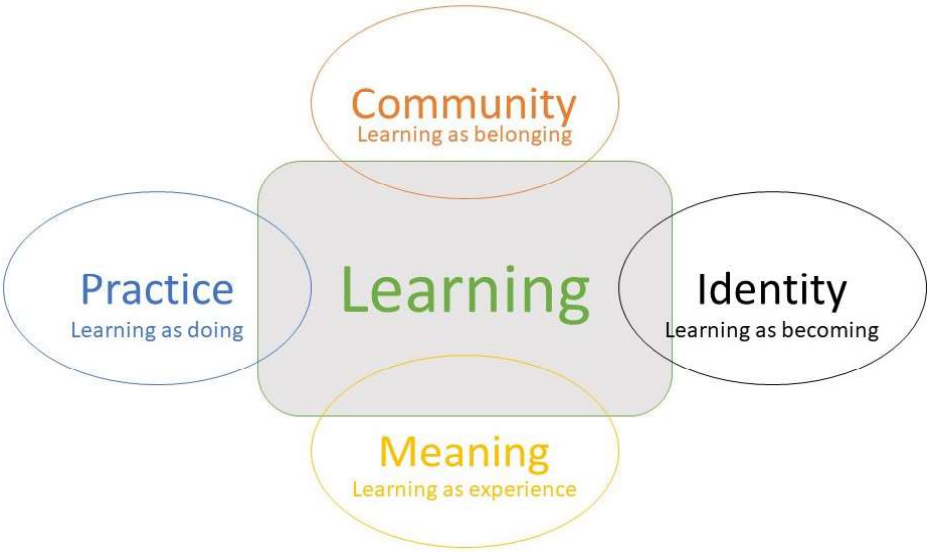

Figure 3.2: Communities of Practice with learning in the center

2. *Practice: a way of talking about the shared historical and social resources, frameworks, and perspectives that can sustain mutual engagement in action.*
3. *Community: a way of talking about the social configurations in which our enterprises are defined as worth pursuing and our participation is recognizable as competence.*
4. *Identity: a way of talking about how learning changes who we are and creates personal histories of becoming in the context of our communities."*

Wenger [89] further elaborates about how one can understand learning, where individual learning is understood as engaging in and contributing to communities. In discussing the idea of learning in communities, he describes communities as having to refine and rethink their practice to involve new members. For organizations, learning is perceived as making the organization effective and valuable through making interconnected CoPs sustainable [89, p 7-8].

CoP is closely linked to the development of competence and the practice, and is a *"collection of people with a joint enterprise, mutual engagement, and a shared repertoire"* [89]. According to Mercieca [55], these terms have new names called *"domain, community, and practice"*. In this project, we use the old names of these terms to avoid confusion. A joint enterprise is to have a collective understanding of their community and what the community is or is not. Competence in a joint

enterprise is understood as knowing their community or domain so well that they can contribute to it [89, p 229]. Mutual engagement is understood as the norms and relations of which a community consists. To be competent through mutual engagement is to engage in the community in a way that is trustworthy [89, p 229]. A shared repertoire is understood as the experiences, stories, tools, and matters of how to address problems in a company, in other words, a shared practice [55]. To be competent here is to know the practice, e.g., in forms of repertoire, and how to use it appropriately [89, p 229].

As participation, or non-participation, in a community is essential for learning and identity formation, it is important to know that there exist different forms of participation. Participation in a community exists on a continuous scale from being a peripheral to full member. This could be something you decide yourself, e.g., where you do not want to identify with the community even though you have the same practice, and you, therefore, are a peripheral member, or it might be that you have just entered the community and need to learn their rules first. It could also be that others do not welcome you to the community and that you therefore only become a marginal member.

One does not only participate in one community but in several, which gives people multi-membership. A broker is a person that is a member of multiple communities and brings with them knowledge and competence from one community to another community, challenging the negotiation of meaning in the communities. However, not everyone is a broker: it depends on which form of participation you maintain in different communities [89, p 109].

As mentioned, participation and non-participation are essential for identity formation, as we use the communities *"to define and affect our relations to the rest of the world, it shapes such fundamental aspects of our life"* [89, p 167-168]. It gives an opportunity to reflect on our location in the social landscape, giving implications for what we care about, what we want to understand, and which connections we seek, as well as what we neglect, ignore, and avoid. Participation shows where we put our energy and engage, and where we try to direct our trajectories [89, p 167-168]. Trajectories are not directed towards a predetermined goal or destination but are a continuous movement *"that has a momentum of its own in addition to a field of influencers. It has a coherence through time that connects the past, the present, and the future"* [89, p 154]. An identity is a trajectory in time that incorporates both past and future into the meaning of the present [89].

Identity could be seen as a continuous process of constructing who you are, and where you belong, and as a negotiated experience where *"we define who we are by the ways we experience our self through participation"* [89, p 149]. Wenger argues

Figure 3.3: Communities of Practice seen through identity

that identity is temporal and needs to be continuously negotiated as it is constructed in a social context. However, it is more complex than a linear notion of time, since it is defined by multiple similar and contrasting trajectories [89, p 154]. *"The way Wenger describes identity [...] is seen as something that forms and constrains the development of a person and not as something that can be located within an individual"* [63, p 3].

Competence is closely connected to identity formation. When using identity as a lens we see that participation in communities is understood as competence. We know ourselves through what is known and familiar, as well as identifying who we are not through what is unfamiliar and foreign [89, p 153]. Looking at practice through the lens of identity, we see that it is not only about our self-image, but also how we live our lives, and how we constantly negotiate the self [89, p 151].

Within identity, we find modes of identification [91] (formerly known as modes of belonging [89]), which consist of three components:

1. **Engagement:** This is active involvement in practices where negotiation of meaning is present [89]; it is *"engaging in practice, doing things, working on issues, talking, using and producing artifacts, debating, and reflecting together. On our learning journey, engagement gives us direct experience of regimes of competence, whether our engagement is a visit or a lifetime com-*

mitment" [91, p 20]. In a higher education setting, students should engage in communities where they learn new things, and experience and develop their own competence.

2. **Imagination:** *"We use images to locate and orient ourselves, to see ourselves from a different perspective, to reflect on our situation, and to explore new possibilities". [...] "These images are essential to our interpretation of our participation in a landscape"* [91, p 21]. The images connect through time and space, drawing on our experiences to imagine the future [89]. We can only imagine what we already know or are familiar with [24] or *"conceptualize something from another person's narration and description of what he himself has never directly experienced"* [87, p 17]. When the new is created, the unfamiliar becomes familiar and seems natural to us [23]. In a higher education setting, this could refer to students' ability to imagine themselves in a future job and how their present choices can affect the future.

3. **Alignment:** To make our engagement in activities be valuable or effective, there needs to be alignment with the communities with which we engage. This could be in the form of following rules or norms, or it could be through the coordination of activities. *"[I]t is a two-way process of coordinating enterprises, perspectives, interpretations, and contexts so that action has the effects we expect"* [91]. In a higher education setting, alignment between the university and the discipline is necessary to make sure the university teaches students relevant rules, norms, skills, and knowledge from the discipline.

In this thesis, I use the lens of identity and modes of identification to look more closely at employability.

Chapter 4

Research Methodology

This chapter consists of three main sections. The first section starts with positioning the thesis in the philosophical view of pragmatism in combination with social constructivism. The second section elaborates on the design of the project and the foundation for my choices. Next, section three will present the context for the study and an overview of the research process included practical method procedures and analyses.

4.1 The philosophical positioning of the thesis

In the pragmatic tradition, researchers agree that *"research always occurs in social, historical, political and other contexts"* [20, p 11]. This leads to pragmatism being *"concerned with investigating the first principle of social worlds, namely, that they are composed of things, parts, linkages, and wholes"* [74, p 5].

As pragmatism is open for different philosophical positions and argues that research always occurs in a social context, I have chosen to combine pragmatism with social constructivism. *"[Pragmatism] is an approach that aligns with social constructionism in its commitment to the need to seek out and accommodate many different perspectives in any social setting where decisions are being made. It also shares the assumption that reality is complex and that agreement regarding what is and what should be in given situations is something that is best negotiated among all interested parties"* [52, p 5]. Higher Computing Education could benefit from adopting social constructivism in combination with pragmatism as its dominant research paradigm, as it is an approach that provides a strong and rich theoretical framework that is in tune with the complex socio-technical domains that Higher Computing Education researchers investigate. I will first present pragmatism and

then social constructivism.

4.1.1 Pragmatism

The pragmatic tradition was founded by Charles Sanders Peirce, William James, and John Dewey [41]. The founders thought that focusing on the consequences of an idea would discover the meaning of the idea. The practical and empirical findings would help decide *"which action to take next as one attempts to better understand real-world phenomena"* [41, p 17]. Researchers should be concerned with the utility of their research when identifying practical implications. According to Yvonne Feilzer [96], there is a need to question who the findings are for, what the research is attempting to do, and how the research is conducted to make the *"inquiry more than an attempt to 'mirror reality'"* [96, p 8].

As an alternative paradigm, pragmatism accepts that there are multiple realities and focuses on solving practical problems [96] in which it is important to stay as close to the practical, empirical reality as possible [3]. This has allowed researchers to focus on the problem and use all appropriate approaches to understand the problem [20].

A pragmatic worldview allows one to research a problem with the use of different methods and is not locked to a particular research method according to [70], cited in [96]. Mixed methods were found useful to address the research questions in this thesis. Pragmatism and mixed methods are often used together, as pragmatism *"offers an immediate and useful middle position philosophically and methodologically. [... As] it offers a method for selecting methodological mixes that can help researchers better answer many of their research questions"* [41, p 17]. This paper has used a mixed-methods approach, see section 4.2.

4.1.2 Social Constructivism

Social constructivism originates from constructivism [5]. The difference between social constructivism and constructivism is that the latter can separate the social context from knowledge creation and learning. In contrast, social constructivism argues that knowledge is a product of social interactions, and that learning cannot be separated from the social context [88]. Individuals negotiate meaning through their experiences and ideas, which always happens in a social context.

Vygotsky argues that learning starts before children attend school: *"any learning a child encounters in school always has a previous history"* [88, p 84] since learning is based on previous experiences.

Vygotsky presented the zone of proximal development (ZPD), which stands for *"the distance between the actual developmental level as determined by indepen-*

dent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" [88, p 86]. When students collaborate with more capable peers, they can participate in learning processes and develop knowledge and experiences that they could not do independently [88, p 86-87].

In the social constructivist view, *"internal and external action* [are] *inseparable: imagination, interpretation and will are the internal processes carried by external action"* [88, p 100]. Social constructivism also sees motivation as extrinsic, i.e., motivated by rewards from the knowledge community, as well as intrinsic, i.e., based in students' individual drive to learn [15].

Using social constructivism as a view in this thesis indicates that employability is a social construct that exists in interactions with others, where developing employability happens in social settings. For example, in a hiring situation, employability needs to be negotiated between a graduate and an employer, while in education or in employment, employability needs to be negotiated between peers.

Situated learning theory [49] is one of many learning theories that originated from social constructivism, and we use the Communities of Practice framework in this thesis, which stems from situated learning theory.

4.2 Research Design

This thesis has the overarching research question *"What characterizes students' employability development in higher computing education, and what can be done to facilitate employability development in higher computing education?"*. This question is addressed through three research sub-questions, which have been investigated using mixed methods research, combining interviews with quantitative surveys.

Mixed methods can be conducted in several different designs, and this PhD project used an exploratory design where the qualitative method is conducted before the quantitative method. The data collected for the qualitative method inform the quantitative method [8]. This will be further elaborated in section 4.3.2.

Qualitative method research: As this thesis seeks to explore and to get and understanding of students' personal employability development, alumni's previous and continuous employability development, and employers' sense of graduates' employability in a hiring situation, one of the research methods was interviews (P1, P4, P5). The interviews were semi-structured, which allowed me to use an interview guide with thematically related questions, but also to ask follow-up questions to the informants. This made it possible to understand the statements from

the informants better, and it gave richer insights into their world.

The qualitative interview method has limitations, such as the fact that both the informant and researcher form their questions and responses based on each other's presence [19], or that the knowledge produced may not generalize to other people or other settings [41]. To accommodate these threats, I told the informants that there is no right or wrong answer, and that I was curious about their personal beliefs and ideas. I also did present my technological education, so that the informants would know they could use technical terms during their interviews. When it comes to generalization of the findings, I have described the context and been specific on what findings are transferable to others in each article.

Some of the strengths of qualitative methods involve providing understanding and description of people's personal viewpoints, which can determine how an informant interpret questions by providing definitions or being available to answer questions, and they are useful for studying a limited number of cases in great depth [41].

Mixed method research: In addition to using qualitative methods in investigating some of the sub-questions, I also used a mixed-method design in P2 and P3. Such research is defined by Creswell as *"an approach to research [...] in which the investigator gathers both quantitative (closed-ended) and qualitative (open-ended) data, integrates the two, and then draws interpretations based on the combined strengths of both sets of data to understand research problems"* [18, p 2].

In this project, I have chosen a mixed-methods approach for complementary and developmental reasons. According to Greene et al. [31], these are two of the five main reasons to choose mixed methods; the reasons include 1) triangulation – where convergence between data from different methods is the goal; 2) complementarity – where clarification, elaboration, or illustration of one method with results from another method is the goal; 3) initiation – where the goal is to reframe the research question through the discovery of contradictions; 4) development – where one method is used to inform the other method; and 5) expansion – different methods help to broaden the research breadth or range [31].

Previously, qualitative and quantitative research were two traditions that it was thought should not be combined [41]. Qualitative researchers use interviews and observation to get a closer view of the individual and Lincoln and Denzin [50] argue that *"quantitative researchers are seldom able to capture their subjects' perspectives because they have to rely on more remote, inferential empirical methods and materials."* On the other hand, *"[m]any quantitative researchers regard the empirical materials produced by interpretive methods as unreliable, impressionis-*

tic, and not objective" [50, p 12]. Mixed methods are a relatively new methodology and originated in the late 1980s. According to Creswell and Creswell, it came from initiatives in diverse fields such as education, management, sociology, and health sciences" [20]. However, mixed methods have become increasingly used and received more attention during the last decades. Johnson and Onwuegbuzie suggested that mixed methods constitute a third research paradigm, in addition to qualitative and quantitative methods [41].

4.3 Research Process

This section outlines the overall structural context for the research presented in this thesis. The research is situated in the Higher Computing Education context in Norway. Further, an elaboration of the specific research context is presented before the data collection and analysis used in this thesis are described. At the end, a comprehensive overview of paper, paper aim, design type, analysis, and paper connection to RQ and contribution is shown in table 4.2.

4.3.1 Context

To carry out the project, it was necessary to get access to informants among the students in a computer science department, as well as the employers hiring graduates from these study programs. As the research is being conducted in Norway, it is essential to elaborate on the Norwegian context so that international readers can understand similarities and differences with their own context. After the elaboration on the structural context, the research context, with information about the study program and the university, is explained.

All children in Norway go to compulsory school from 1st to 10th grade before choosing which specialization to study in their high school. High school is not compulsory, but it is highly encouraged and free for all. There are two main options when applying for high school: vocational study programs that could lead to trainee positions and jobs after high school and other study programs that are more geared for continuing into higher education. After high school, a student must use the system "Samordna Opptak" where students compete for places in their preferred study programs based on their grades. Both high school grades and the electives (and specialization) define which higher education study program to which they could be admitted. In Norway, everyone is entitled to education, and all education is entirely free (these are public schools funded by the government; however, some pupils/students go to private schools, but this is not common. The private schools are not free). To make sure that students in higher education focus on their education, most students get scholarships and loans from the government to cover their living expenses during their studies (for a maximum of eight years).

In short, everyone in Norway gets free education, and they could qualify for every study program.

Higher education study programs are either a one-year program, a three-year-long bachelor's study program, a five-year-long integrated master's program, or a two-year-long master's program that students can attend after their bachelor's studies. When students choose their higher education study program after high school, they start with their specialization immediately. Students can switch their study programs within the same discipline without starting all over, however, changing study programs outside their discipline would in most cases make the student start from the first year again. Since higher education is available for everyone, and the government gives scholarships and loans to most students, some choose to take two bachelor's degrees or a bachelor's and a master's degree.

As explained in chapter 2.2 there is a need for IT workers in Norway. However, the industry does not hire people without education. Many companies market how skilled their workers are. Hiring people without a diploma from higher education often results in a need for certifying the worker and having more onboarding training.

This thesis has used the Norwegian University of Science and Technology (NTNU), with its computer science department, as context of the research. As there are many different study programs, this thesis has chosen to look more closely into three of them. The study programs are different in terms of level, teaching methods, and type of students (see Table 4.1).

Even though it is not a focus in this thesis, it is necessary to elaborate a bit more on NTNU, which has campuses in Trondheim, Gjøvik, and Ålesund (three cities in Norway). NTNU has recently been through a merger between a university in Trondheim (NTNU) and three university colleges: Høgskolen i Sør-Trøndelag (HiST), Høgskolen i Gjøvik, and Høgskolen i Ålesund. Since there was an intention to keep the university name, the rectorate and central administration of the previous university was retained, and in practice the three colleges were merged into the university. This merger has led to several changes for the colleges regarding how courses are managed, how teaching is done, and what counts as competence. The former university focused on the teachers' publications, teaching large classes, and having a more theoretical approach regarding teaching methods and what to learn. The former colleges had a focus on practical learning, innovating and improving teaching, and were teaching smaller classes. These differences between the former colleges and the university are still present to some extent. The following aspects will therefore differ between the three study programs, as the bachelor's programs have their origin in the former colleges and the master's

Level	Name	Years	Students	Teaching Methods
Bachelor's	Information technology with specialization in network administration (ITNA)*	3	Most students are young and come straight from high school.	Practical teaching. Groupwork. Only campus lectures with lab exercises.
Bachelor's	Information Technology with specialization in Information Management (ITIM)	3	A mix of younger and older students. Many students have work or previous education and look at this as further education.	Online teaching. Online group work. Online lectures.
Master's	Master's in "Communication Technology" and "Computer Science"	2	High admission requirements.	Theoretical teaching. Some group work. On-campus lectures.
Bachelor's	Digital Infrastructure and Cyber Security (DIGSEC)*	3	A mix of older and younger students. High admission requirements.	Practical teaching. Groupwork. Only campus lectures with lab exercises.

* = An old (ITNA) and a new (DIGSEC) version of the same study program.

Table 4.1: Overview of study programs researched. Table from article 6.

program from the former university:

- Identity areas: This is a designated area where one study program is located at all times; teaching, lab exercises, and extracurricular activities are located at the same place. Students in the study program in question can always use this area. Identity areas are used for the study programs ITNA and DIGSEC.
- Teamwork: At the bachelor's level, students work in teams from day one, and there are more teamwork-based courses than individual courses. For ITIM, the teamwork happens online, while in ITNA and DIGSEC, the teamwork is on campus. The master's program has some teamwork in later years.
- Practical learning: The bachelor's programs have a high focus on practical ways of learning. The ITNA and DIGSEC have practical lab exercises where students are expected to use servers in a server room, where they need to set up the server and cabling and connect the physical server.
- Online learning: as the ITIM study program is entirely online (except for the exams), all teaching happens online. As it is to a large extent up to teachers to decide how they do online teaching, it differs in how this is done. Some teachers only provide written lessons and assignments, while others provide online lectures with synchronous interactions.
- Collaborating teachers: the study programs from the former colleges are based on collaboration between teachers on the course design and teaching.

One course might have three or four teachers, where each teacher has their own expertise area. In the master's programs, there are often one teacher and several teaching assistants.

- The number of students: In the bachelor's programs, there are generally small classes with around 60 students. In the master's program, there are around 100-140 students each year.

Involvement from study program leaders

This PhD project has taken place in close collaboration with study program leaders. In paper 1, the study program leader for ITNA at that time, André Gaustad, was a co-author, and in paper 2, Leif Erik Opland, the study program leader for ITIM, co-authored. In paper 3, the study program leader Knut Arne Strand designed the survey with the co-author Birgit Krogstie. The head of the department, John Krogstie, was, at the beginning of the PhD project, my co-supervisor and was also a co-author of paper three. In papers 4 and 5, the study program leader for DigSec Geir Ove Rosvold allowed me to present the research in class and answered several questions about the study program as a whole.

This collaboration has secured that the research done in this PhD project has helped provide insights and understanding for each study program. The research has been applied to evaluate study programs or serve as a way for study program leaders to get students' or employers' insights about a study program.

Even though there has been close collaboration with the study program leaders, this collaboration has not affected my research questions. However, the study program leaders have had the chance to give feedback on my interview guides, where some questions have been changed due to me getting new knowledge about teaching methods or coursework.

4.3.2 Data collection, methods, and sampling criteria

In this section, I will briefly present the methods used in the different papers before elaborating on the sampling criteria and sample size for each paper.

The method used for the larger part of the data collection in this thesis is qualitative interviews. However, a mixed-methods approach is used in two of the papers: In papers 2 and 3, an exploratory sequential mixed-methods design was used, where the qualitative data informed the quantitative method [20]. The mixed-methods approach was used in paper 2 for developmental and complementarity reasons [31], while the mixed-methods research in paper 3 was done for complementary reasons, seeking corroboration of the results in order to elaborate, enhance, and

clarify the results from one method with results from the other method [31].

Papers 1, 4, 5, and 6 are based on qualitative research methods in the form of semi-structured interviews. Paper 1 was designed as a "common-case" rationale in a single case, where we aim to capture the circumstances and conditions to answer the research question [94].

Sample size and criteria

This section describes the sampling approach for each paper. The sampling approach includes defining the sample universe and sample size, deciding on a sampling strategy and recruiting the participants, which are the four main points in the guide to sampling in interview-based qualitative research proposed in [69]. All papers had the same sampling strategy, where convenience sampling was used (a sufficient number of respondents from the sample universe). This sampling strategy was also used for the surveys conducted in papers 2 and 3. For papers 1, 2, and 3, the recruitment of informants happened through an initial e-mail sent directly to them. Paper 4 recruited informants through a survey sent out in the classroom, and paper 5 recruited from the informants of paper 4. The sample universe and the sample size for each paper are presented below.

PAPER 1

Criteria: Interviewees: 1) have hired students from the study program, 2) be located in the same country as the study program, 3) Organizations in the SMB segment, 4) department leaders or HR-employees who are decision-makers in the recruitment process. It is worth noting that the study program leader chose the informants.

Size: Initially, 11 invitations were sent to 11 different organizations, and this resulted in 10 interviews with informants from nine of the organizations.

PAPER 2

Criteria: Interviewees: 1) have graduated from the study program in 2016 or 2017. Survey respondents: 1) Graduated from the study program between 2010 and 2018.

Size: Interviews: 28 e-mails were sent, resulting in seven interviews. Survey: a population of 93 possible recipients of the survey, 29 alumni completed the whole survey, 7 answered most of the survey, and 9 alumni did not complete much of the survey or did not want to participate.

PAPER 3

Criteria: Interviewees: 1) have hired students from master's programs, 2) be located in the same country as the master's programs, 3) work closely with students from the master's programs, 4) be a part of a business network initiated by to departments at NTNU. Survey respondents: 1) have hired students from master's programs, 2) be answered by a leader for IT employees or someone else involved in hiring new IT employees.

Size: Interviews: 16 e-mails were sent, which resulted in 11 answers, where 6 respondents were willing to participate. Survey: 50 invitations for the survey were sent out, leading to 10 respondents.

PAPER 4

Criteria: Interviewees: 1) Be a first-year student in the study program, 2) voluntarily sign up to be a part of the research study.

Size: Interviews: 38 students were asked to participate, resulted in 8 interviews with first-year students in the middle of their first semester.

PAPER 5

Criteria: Interviewees: 1) Participate in the interview round of paper 4, 2) still be a student in the study program.

Size: Interviews: Of 8 initial students from first interview round (paper 4), 6 students were willing to participate.

PAPER 6

Paper 6 builds on empirical findings presented in the other five papers.

4.3.3 Data Analysis

QUALITATIVE DATA:

All interviews have been analyzed inductively, using NVivo. All of the qualitative data in this project have undergone thematic inductive analysis following Braun and Clarke's six phases of thematic analysis [10]. There has been an iterative analysis process, where the codes emerged from the material, going from text-based coding to categories [19], and the analyses can be described as a *"systematic search for meaning"* [34, p 148]. We chose this analysis as they are characterized by how the interpreter goes more profoundly into the data, beyond what is explicit and identifies structures and relations that are "hidden between the lines" in a text [34], [47], [75], which was what we were looking for when using a qualitative method.

Paper	Aim	Selected data	Design type	Data analysis	RQ	C
1	Understand what the industry is looking for when hiring an IT graduate in Norway. What makes them choose one applicant over another	10 Interviews, responsible for hiring	Qualitative interview design	Thematic inductive analysis	RQ3	C3
2	Understand how perceived employability developed before, during, and after HE	7 interviews, alumni. Questionnaire, alumni, 36/93 respondents	Exploratory design (QUAL ->QUAN)	Thematic inductive analysis. Descriptive statistics	RQ2, RQ3	C2, C3
3	Understand what graduates need training in and how long time they use to become fully operational when hired	6 interviews, train newly hired graduates. Questionnaire, responsible for hiring, 10/50 respondents	Exploratory design (QUAL ->QUAN)	Thematic inductive analysis. Descriptive statistics	RQ1, RQ2, RQ3	C1, C2, C3
4	Understand students' work prospects and imagination of future	8 interviews, students	Qualitative interview design	Thematic inductive analysis	RQ1, RQ2, RQ3	C1, C2, C3
5	Understand students' Imagination, Alignment, and Engagement development during their first year	6 follow-up interviews, students	Qualitative interview design	Thematic inductive analysis	RQ1, RQ2, RQ3	C1, C2, C3
6	Understand how higher computing education can emphasize employability when understanding it as identity formation	5 papers	Review of findings from paper 1-5	Modes of identification lens on findings from paper 1-5	RQ1, RQ2, RQ3	C1, C2, C3

Table 4.2: Overview of each paper and the type of data, design type, and analysis used.

QUANTITATIVE DATA:

In the analysis of paper 2, there was both qualitative and quantitative data. For the latter, we used descriptive statistics, which *"describe the situation without addressing any relationships between variables or groups,"* as well as measuring Chi-square (categorical variables (have had job pre-edu, have not had job pre-edu)) and t-test (continuous variables (from pre-edu to post-edu) [8, p 54-55]. We chose this analysis as there was interest in finding out the relation between employability development for those with and without job experience before education.

In paper 3, the quantitative data collection had ten respondents. We used these data to supplement the qualitative data collection. Some answers were open-ended, where respondents could type in an answer; here, inductive analysis was conducted. For the closed questions, we used the answers as industry indicators, as the respondents were too few to give generalizable outcomes.

Chapter 5

Results

This section will present the results, as achieved through the papers included in this PhD project. The papers presented in this thesis consist of four conference papers, one journal article, and one article that has been submitted to a journal. Each has been peer-reviewed. The papers in their full length can be found in part II. The papers are presented in chronological order based on the time of writing. For each paper, there will be a presentation of:

1. Title
2. Authors' names
3. Authors' contributions to the paper
4. Where the paper is published
5. Abstract of the paper
6. A short description of the main findings
7. The paper's relation to the research questions

Table 4.2 in the method section outlines the connection between RQs and contributions from the papers.

5.1 Paper 1

Title: The Employer Perspective on Employability

Authors: Gunhild Lundberg, André Gaustad, Birgit Krogstie

Authors' contributions: Lundberg and Krogstie did the conceptualization of the idea and research goal. Lundberg did the investigation, including the formulation of the interview guide and data collection. A student assistant transcribed the interviews. Lundberg, Gaustad, and the student assistant did the formal analysis collectively. Lundberg led the paper writing and took the main responsibility for writing, publishing, and presenting the article. Krogstie and Gaustad provided a review and editing of the article.

Published: EDUCON – IEEE Global Engineering Education Conference – 2018 – Tenerife, Spain

Abstract: "Employability" is a term used for describing the skills, knowledge and personal qualities a graduate should possess to get a job. In this paper, we suggest what these skills and qualities are for IT undergraduates specializing in network administration. We have interviewed 10 recruitment managers from 9 different companies who have employed candidates from an IT network administration study program. They suggest that personal qualities are the most important aspect they look for in the graduates. We found that several of the recruiters want the graduates to also have an interest in technology outside of the curricular activities or work setting. This type of interest is taken as a sign that the graduate/job seeker is able to employ their knowledge in practice and engage in continuous self-development and lifelong learning, validating their employability. We discuss how the university can provide curricular as well as extra-curricular activities, thus leveraging as well as developing the interests valued by employers.

A description of main findings: This paper gives deeper insights into what employers value when they hire graduates. The paper shows that students' interests and extra-curricular activities are of high importance in a hiring situation. Having an interest within the discipline can validate students' higher education grades.

The relation to research questions: This paper addresses RQ3 and argues that higher computing education should facilitate students' employability development by emphasizing extra-curricular and hobby activities. Through providing students with identity areas and accessible technology (like servers) students have the ability to also engage in meaningful activities for the community in addition to curricular activities.

5.2 Paper 2

Title: Perceived Employability in Online Education

Authors: Gunhild Lundberg, Leif Erik Opland

Authors' contributions: Lundberg did the conceptualization of the paper's idea and research goal, the investigation with interviews and questionnaires, and the formal analysis. A student assistant transcribed the interviews. Opland gave insight into the study program and wrote about its context. Lundberg took the main responsibility for writing, publishing, and presenting the article.

Published: UDIT – Norsk Konferanse for Utdanning og Didaktikk i IT-fagene – 2019 – Narvik, Norway

Abstract: In this paper, we use an online bachelor's study program in IT as a case for research on Perceived Employability (PE). Collecting data from alumni through interviews and a survey we find an increase in students' PE during their bachelor education. We also find a difference between students who had relevant work experience before their studies and those without such experience, the former having higher PE before their education. This gap decreases and is not significant after completion of the bachelor's program, except for the aspect of Contact Network. We discuss the results in light of how PE can be used as a construct in the evaluation and development of the specific bachelor's program of our study and other study programs. We suggest that PE can be used to measure some important aspects of a study program, but as part of an overall evaluation, it should be combined with questions about competence and satisfaction.

A description of main findings: This paper looks into what alumni of an online bachelor's program thought about their development of employability before, while and after enrollment in that program. The findings show that the students' contact networks did not develop during the course of their education, and we suggest that higher education institutions emphasize this more. We suggest that the framework of Perceived Employability can be used as a quality tool for study programs' self-measurement of students' employability development.

The relation to research questions: This paper contributes to RQ2 by looking into students' perceived employability, and argues that online higher computing education in combination with relevant job experience influences students' employability development. The paper also contributes to RQ3 by arguing that perceived

employability does increase during online education, however, contact network does not increase.

5.3 Paper 3

Title: From Employable to Fully Operational: The Need for Training of Computer Science Graduates

Authors: Gunhild Lundberg, Birgit Krogstie, John Krogstie

Authors contributions: Lundberg and B. Krogstie formulated the ideas for the paper. Lundberg developed the interview guide, which two student assistants used for the interviews. A questionnaire was designed and conducted by B. Krogstie and the study program leader Knut Arne Strand. Lundberg did formal analysis of the data and took the main responsibility for writing, publishing, and presenting the article. J. Krogstie provided review comments of the paper.

Published: International Journal of Engineering Pedagogy

Abstract: For graduates in computer science and informatics to get employment as IT professionals, there is a need for their education to provide the competence sought after by employers. To become fully operational in the organization, the candidates typically also need to further develop their competence there, engaging in activities, and becoming familiar with the practices in the company. For a university offering master's degrees in computer science and informatics, it is important to know the employers' view of the relevance of the study programs and what is possibly considered to be lacking. Also, it is essential to know whether the missing part needed to become fully operational should be provided by the university. In this paper, we investigate these questions by asking employers of master's students in IT. As a significant new contribution, we use the framework of modes of identification by Wenger-Trayner and Wenger-Trayner to find out if the graduates are aligned with the discipline, engaged in activities, and able to imagine their future in an IT position. A combination of in-depth interviews and a survey is used. Analysis of the findings shows that employers overall find the candidates' competence from the university to be adequate. We argue that collaboration between university and industry is essential to this success, pointing to a set of key steps in the process from entering a study program to becoming fully operational in work life.

A description of main findings: The paper found that there is a need for training of graduates after hiring. If a graduate is not well aligned with the discipline, it would be harder for the company to prepare the graduate to be aligned with the company, since many of the discipline-specific practices are also used by companies. The paper also points out how the process of becoming fully operational starts from the first year at university and continues in students' training period after being hired by a company.

The relation to research questions: RQ1: The paper shows that modes of identification could be used to enrich the employability perspective from focusing primarily on skills, knowledge, and personal attributes; to being aware of how students are aligned with the discipline, engaging in meaningful activities for the discipline, and having the experience and narratives necessary to be able to imagine themselves in their future work. RQ2: The paper argues that companies have a substantial impact on students' employability development through company presentations, guest lectures, summer jobs, the recruiting process, and the training that students receive after being hired. RQ3: The paper could facilitate student employability development through having close collaboration with the industry. They should also focus on minimizing the gap between higher computing education and the computing discipline - this can be done through having projects or work experiences.

5.4 Paper 4

Title: Students' Imagination of Future Employment – Identity as an Important Employability Aspect

Authors: Gunhild Lundberg, Ingunn Johanne Ness

Authors contributions: Lundberg formulated the idea for the research paper, developed the interview guide and did the investigation. The transcriptions were done by student assistants. Lundberg did the formal analysis and had the main responsibility for the writing, publication, and presentation of the paper. Ness contributed the theoretical framework and offered review comments on the paper.

Published: CSERC - Computer Science Education Research Conference – 2021 – Online, Netherland

Abstract: One of the main goals of higher education is to make students employable. Employability is known as skills, knowledge, and personal attributes a person should possess to become employed. In this article, however, we use the processual perspective on employability, which emphasizes identity formation. We argue that employa-

> bility includes the students' ability to imagine their future work and employment possibilities and see themselves as part of a computer science profession. We use sociocultural theory as an analytical framework and have found the concept of imagination to be fruitful in shedding light on how first-year students imagine their future job. Through eight qualitative interviews with first-year cybersecurity students, we found that students had difficulties imagining their future dream job. We find that the students had not developed a computer science identity, even though the study program has some focus on identity formation by teaching discipline-relevant courses from the first semester. In addition, companies visit the school and present their interests, and finally, some of the courses offer real-world scenarios in which the students can engage. The study implies that it is important that a study program pay particular attention to students' identity formation and to making sure that enough time is spent on giving the students information about future employment possibilities.

Description of main findings: The paper indicates that students want and need more information about their future work possibilities, to be able to imagine themselves in a future discipline-specific job. The article argues that students have not developed their discipline-specific identity in their first semester, and they are therefore unable to imagine themselves in a future job. Students get information about future jobs from teachers, students in higher grades, companies, and guest lectures.

The relation to research questions: RQ1: we see that identity and imagination are an essential part of the employability term, where imagining their future employment and being aware of their job possibilities is an important part of developing a disciplinary identity, as well as developing employability. RQ2: The paper argues that students' imaginations are influenced by visiting companies, taking discipline-specific courses, learning from work-life scenarios in lectures, and talking with other students. RQ3: To facilitate students' employability development, the paper suggests that higher computing education should give more specific information to students regarding their future jobs and how their present choices can affect their future. Students need diverse narratives and information about future jobs to be able to imagine their future opportunities.

5.5 Paper 5

Title: Employability Through Imagination, Alignment, and Engagement - Students' Prospects and Change During Their First Year in Computing Education

Authors: Gunhild Lundberg, Birgit R. Krogstie

Authors contributions: Lundberg and Krogstie formulated the paper idea and research goal, as well as developed the interview guide together. Lundberg held the interviews, did the formal analysis, writing, publication, and presentation of the paper. Krogstie provided feedback and help with the final revision of the paper.

Published: Koli Calling – Koli Calling International Conference on Computing Education Research – 2020 – Online, Finland

Abstract: Employability can be defined as a part of one's identity formation, or pre-professional identity formation. In this paper, we have interviewed six computing students at the beginning of their first semester and in the middle of their second semester, exploring their perspectives on being a student and future professional. The results show that students have started their identity and employability development by aligning themselves with the practices in the computing discipline, engaging in a study program community, and starting to imagine their future professional identity. The article gives recommendations on how Wenger-Trayner & Wenger-Trayner's concept of modes of identification can be used to enhance employability in first-year computing education.

A description of main findings: The paper found that modes of identification were essential when developing employability. It also points out that employability development happens from students' first year.

The relation to research questions: RQ1 and RQ3: This paper uses modes of identification as a lens to investigate employability development. By using modes of identification, we see that higher computing education should encourage students' holistic reflections on their lives and studies, broaden the computing discourse to also include societal perspectives, and introduce students to how a normal workday in the industry would be, to help students develop their employability. RQ2: The paper suggests that the university, companies, and industry influence students' employability development. The industry by having guest lectures and company presentations, which can affect students' imagination and alignment. The university can influence students' employability development by providing discipline-specific courses, teachers with industry backgrounds, and a learning environment with labs and identity areas.

5.6 Paper 6

Title: Understanding Employability Through an Identity-Formation Perspective — Implications for Higher Computing Education

Authors: Gunhild Lundberg, Birgit R. Krogstie, Guttorm Sindre

Authors contributions: Lundberg and Krogstie formulated the paper idea and research goal. Lundberg did the formal analysis of findings and had the main responsibility for writing and submitting the paper. Krogstie and Sindre provided feedback and suggestions for literature to include, as well as help with the final revision of the paper.

Published: In review to Journal of Industry and Higher Education, July 2021

Abstract: **Background and Context:** One goal of higher education is to educate employable graduates. 'Employability' is often used as a term for defining whether students have developed the appropriate skills and knowledge to become employable. However, in this paper, we argue that employability is closely related to identity formation.

Objective: The research objective is to explore how teachers and educational leaders can facilitate students' employability development.

Method: We present the main findings from five empirical papers in a PhD project and analyze them through the lens of 'modes of identification' by Wenger-Trayner and Wenger-Trayner.

Findings: We found that using 'modes of identification' as a lens in employability emphasizes the importance of students' alignment to the discipline, engagement in activities meaningful for the discipline, and imagining themselves as discipline professionals.

Implications: We provide a set of guidelines for how employability can be facilitated in higher computing education. The guidelines suggest the importance of close industry collaboration, teacher participation in discipline communities, ensuring diversity in role models and perspectives, encouraging students to develop interest and participate in hobby activities in the discipline, holistic reflection opportunities, and learning opportunities closely related to work-life.

A description of main findings: The paper summarizes the main findings from the previous papers and suggests guidelines for how employability can be facilitated by teachers and educational leaders in higher computing education. Even though

teachers have the main responsibility for implementing the suggested guidelines, educational leaders must ensure that teachers have the ability to meet those guidelines in terms of considerations such as time, money, and opportunity. The paper also argues that the framework of modes of identification is a useful lens when researching employability. Some of the findings and implications are explored in the current literature; however, this framework combines those findings in a comprehensive and holistic approach to employability.

The relation to research questions: RQ1: The paper argues that using the lens of modes of identification gives a comprehensive view of employability as entailing the formation of a disciplinary identity. RQ2: The paper argues that industry collaboration, curriculum activities closely related to industry, role models and diverse perspectives influence students' employability development. RQ3: The paper suggests guidelines for how employability should be facilitated in higher computing education. It suggests that teachers participating in the disciplinary community is essential, as it can lead to industry collaboration, teachers having updated knowledge, and teachers providing learning opportunities that are closely related to work-life considerations.

Chapter 6

Discussion

This section will answer the research questions, state the contributions drawn from these questions (see table 6.1 and 6.2), and provide practical and theoretical implications. It will then provide an answer to the overarching research question. Thereafter, some reflections and evaluations on the project will be presented.

The first aim of this thesis was to provide a deeper insight into students' employability in higher computing education. The second aim was to enhance the understanding of employability by connecting it to the CoP theoretical framework. The third aim was to contribute knowledge and a new understanding of employability in order to improve higher computing education. By answering research questions 1, 2, and 3, we have reached these aims and made three main contributions.

	RQ1	RQ2	RQ3
C1	•		
C2	(•)	•	
C3		(•)	•

Table 6.1: Connections between research questions and contributions

	P1	P2	P3	P4	P5	P6
C1			•	•	•	•
C2		•	•	•	•	•
C3	•	•	•	•	•	•

Table 6.2: Connections between research papers and contributions

6.1 Research questions and contributions

Figure 6.1 illustrates how the papers relate to the contributions and where they are positioned on the trajectory from first-year students to employed graduates. C3 gives implications for higher computing education and includes all papers as they all have findings contributing to C3. It is also an implication that employability should be seen as a process, and that modes of identification are essential for employability. C2 argues that employability should be seen as a process, and it involves papers 2, 3, 4, 5, 6. C1: Modes of identification are located within C2, as seeing employability as a process makes it possible to use modes of identification as a framework. C1 states that employability can be seen through a modes of identification lens, which entails imagination, engagement, and alignment, and it involves papers 3, 4, 5, and 6.

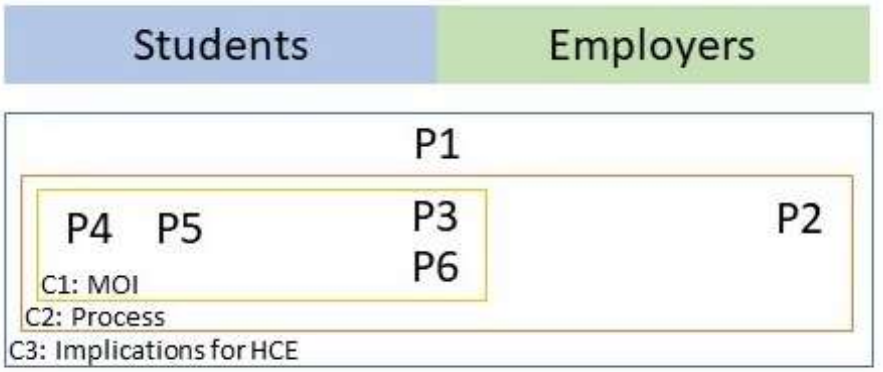

Figure 6.1: Linkage between papers, contributions, and informant group

6.1.1 RQ1

Research question one was: *How can the concept of employability be enriched by a perspective focusing on modes of identification?*

This PhD project has shown that the dominant perspective on employability is too narrow, as, e.g., hobbies, interest in the discipline, and ability to see oneself in a future job are not emphasized. When using a modes of identification lens on employability, we are able to include hobbies, interests, and future prospects into the employability term, and set students' identity formation on the agenda. This gives importance to aspects like candidates' alignment to the discipline, engagement in meaningful activities, and ability to imagine their future.

This PhD project has focused on higher computing education. Using modes of identification as a lens, we put emphasis on the feeling of belonging and identifying with the discipline. Through a focus on diversity, both in terms of role models and company presentations, students can identify with someone in the industry and become aware that they belong in this discipline. Traditionally, computing education has been viewed as becoming a programmer [2], however, a graduate with a computing education has many other opportunities. By including perspectives where the focus is moved from what a graduate does (programming), to what they can affect and help (society, health, national security), higher computing education can motivate and help students who intend to pursue other work prospects feel that they belong.

Despite having a processual view on employability in this thesis, I assume that the hiring situation will still use grades and skills/knowledge (the possession perspective) to evaluate students applying for a job. However, having a disciplinary identity might help students communicate their identity and employability to the employer in a way that can be affirmed and thus lead to them being hired.

Modes of identification might not be used in every setting. If the job market is changing very fast, current students are educating themselves for jobs that do not yet exist. This can challenge the modes of identification perspective. Students can find it hard to identify with and imagine working in an undefined job. However, unless there is a new discipline emerging, students are able to align to the discipline and be engaged in activity that is meaningful for the discipline. The imagination aspect encourages students to reflect on and explore new possibilities [91], which can be an advantage when not knowing what job opportunities will be available in the future.

This thesis is within a higher computing context, however, using a modes of identification lens on employability could be beneficial for other contexts as well. The need for belonging, having a sense of purpose, and envisioning yourself in a future job are all general needs that are not specific to just computing specialists or students. A rapidly changing job market can also use modes of identification, as employees might have the need for re-education when changing job positions. Thus, modes of identification might be relevant for people throughout their work-life experiences and not just in the transition from higher education to work-life. These three modes of identification should be included in higher education's consideration of students' employability development.

6.1.2 Contribution 1

C1: *Contributed to the employability research field by a deeper conceptualization of employability, achieved by using modes of identification as a lens.*

Traditionally, employability research in higher education has been dominated by a possession perspective where knowledge and skills have been the focus [36]. This thesis argues that this is a too narrow view of employability. Through a modes of identification perspective, we see that employability is closely related to identity formation which has already been explored in the current literature [36, 39, 30, 43, 84]. Using modes of identification as a lens extends this literature by taking alignment, engagement, and imagination into account. By aligning with the discipline, engaging and participating in activities viewed as meaningful for the discipline, and being able to imagine their future by connecting the past and present, students form a discipline-related identity that makes them employable. Table 6.3 links the findings in the papers to modes of identification. Employers can find evidence of engagement and alignment in different ways according to paper 3: Some suggest that grades can indicate students' engagement and alignment, while others argue that hobbies and interests give evidence of engagement and alignment in students. Even though students are aligned with the discipline, a training period is required when starting a job, so that graduates become aligned with the company's rules, norms, and way of working.

Paper 4 looks into the need for imagination in education, and it considers how higher education can facilitate students' imagining of a future job or profession. Paper 5 goes further, adding alignment and engagement to imagination, and suggests that to make students employable is to make students aligned with the discipline, engaged in relevant activities in their community and disciplinary community, and able to imagine a future work role.

Engagement in meaningful activities for the discipline's community is important for students' identity formation and employability development. Through participation in communities, students develop competence understood as essential for a community. Participation and engagement in diverse communities relevant for the discipline, allow students to develop competence often understood as employability when using the possession perspective [36]. However, engagement also allows for alignment with the discipline, as students gain the relevant competence as well as rules, norms and the practice used in the discipline. By engaging in activities, students get personal experiences, as well as insight into other people's narratives. It is hard for students to imagine something they do not know [24], and through exploration of communities and the narratives of others, they can be able to imagine their future in the discipline.

	Alignment *Aligning to the discipline through...*	Engagement *Engaging in relevant activities through...*	Imagination *Imagining the future through...*
Paper 1	Having the right skills and knowledge	Having hobbies and interest is to engage in meaningful activities for the discipline	
Paper 2	Relevant job experience prior to their education	Employment or hobbies. This will increase students' contact network during higher education	Being able to know where they can be hired tomorrow
Paper 3	Learning discipline-specific knowledge, practices, and culture	Hobbies, selecting electives, and having summer jobs	Other peoples' narratives through hobbies, student organizations, and company presentations
Paper 4			Receiving enough information about students job possibilities from first year at university
Paper 5	Change of habits and attitudes both in curricular activities and in their spare time. Alignment by becoming aware of challenges in the discipline	A strong class community and practical learning	Getting information about discipline-specific jobs and regular workdays to become able to imagine themselves in a future job. This includes adding societal perspectives in the information about future jobs
Paper 6	Close collaboration with the discipline community	Creation of own experiences and participation in communities	Guest lectures and role models with various narratives

Table 6.3: Each paper's relation to modes of identification.

This contribution gives **theoretical implications** for broadening the employability concept to include aspects of modes of identification. This can improve higher computing education by changing the perspective from a possession perspective with skills and knowledge as the main factors for employment, to a process perspective where students' identity and feeling of belonging is the focus. Through such a shift, higher computing education may get a more holistic view on employability, where the focus on skills and knowledge is reduced, but not absent. Allowing an increased emphasis on identity formation and belonging could explain why some students who would be considered employable according to the possession perspective, still end up unemployed or seeking work outside the discipline in which they are educated. Thus, the shift in perspective gives room for an understanding of other factors essential for employability development.

6.1.3 RQ2

Research question two was: *Which factors influence students' employability development?*

This thesis has investigated different factors for influencing students' employability and found that surrounding people, hobbies, and the ability to imagine a future are factors that influence students' employability development.

Firstly, people have an impact on students' employability development seen from a student perspective. This thesis argues that teachers, company representatives, peers, and students in earlier study years (students in their second, third, fourth, or fifth year) influence students' employability development. In addition, this thesis argues that study program leaders, and institute collaborations with industry affect this development. It is also worth mentioning that the biggest impact on employability development comes from the students themselves.

Through these people (see table 6.4), students get familiar with other people's narratives and experiences. As Dewey [24] states, we can only imagine what we know or are familiar with, and these shared experiences will help to provide students with the ability to imagine their future work opportunities.

Secondly, this thesis suggests that hobby activities or a genuine interest in the discipline is beneficial for students' employability. Such activities and interests can help validate students' skills and knowledge for employers (P1), and evidence of participation in meaningful activities (P3) can help students to imagine their own future (P4), which can indicate for students that they belong in the discipline (P5). Through these hobby activities, students get familiar with different communities and be introduced to different practices and people.

Who	How
Teachers	Through describing what is important, motivating students to engage in hobby activities, developing an interest in the discipline, telling narratives about future work
Peers	Through a collective understanding of who are misfits and who is competent
Earlier students	Through sharing experiences and practices
Company representatives	Through promoting their company as an option for future career, explaining what they seek after
Study program leaders	Through their facilitation of employability in the study program
Industry collaboration	Through close collaboration between industry and institution, the industry could be present when deciding the curriculum
Students themselves	Through participation in the employability development opportunities provided by the higher computing education institution

Table 6.4: Overview of people influencing students' employability development

Thirdly, students influence each other by having an impression of, and thereby conveying an idea of, who is a misfit in the discipline. The students viewed as misfits often had no previous experience, or they had a wish to help society in their future job. Through a modes of identification lens, this could mean that these misfit students were not aligned to the discipline before starting their education and they had a hard time imagining their future. If these students had been presented with different perspectives of future jobs, this misfit conception would have been avoided. Students who talked about this were in their first year, so these perspectives should be presented from day one in their education.

Understanding who is influencing students' employability development can help decision makers in higher computing education understand that it is important to include a diversity of role models in the education. Students' employability development is influenced by the teachers, but also by the surroundings. In this thesis employability development has been researched using a social constructivist view, emphasizing that employability is negotiated between people participating in the relevant communities of practice.

6.1.4 Contribution 2

C2: *Contributed to the employability research field by emphasizing how employability is a process that is ongoing from students' first year of higher education and continues after employment*

The employability literature presented in section 2 is tightly connected to the knowledge, skills and personal attributes that fresh graduates possess, as they move from higher education towards employment by gaining their first job. When looking at employability in this manner, the process easily becomes neglected, and the focus is on a desired end goal for the graduates: what competencies they possess at graduation. Study programs with this perspective focus on reaching the desired learning outcomes rather than identity formation or the process of developing employability.

Some researchers have argued that employability should be seen as a process [36, 39]. However, they seem to have an exclusive focus on employability development throughout higher education. This thesis argues that students' employability development starts prior to higher education, and, more importantly, continues after graduation through employment. Re-conceptualizing employability to a *pre*-professional identity [39] ignores the continuity of employability. Newly employed graduates must acquire new competencies and become more operational in the company; however, they must also maintain their work position and be able to apply for a new or better job. By seeing employability through modes of identification, we see employability as becoming a member of a community, and this participation needs to be continuously updated on the practices, repertoire, norms, and ways of working in the community.

Figure 6.2 shows how employability development can start differently for diverse students: some have not developed discipline-specific employability before higher education, others have experiences that have made them develop some employability before starting their studies. During higher education, students develop employability and form a disciplinary identity. When transitioning from higher education to employment, students negotiate their employability (which includes their disciplinary identity) with potential employers. The employers need to affirm this proposed employability; if accepted, students get a job. Figure 6.2 shows the employability development process, what types of informants I have talked to, and where the insights from the papers fit in the employability development process of the students.

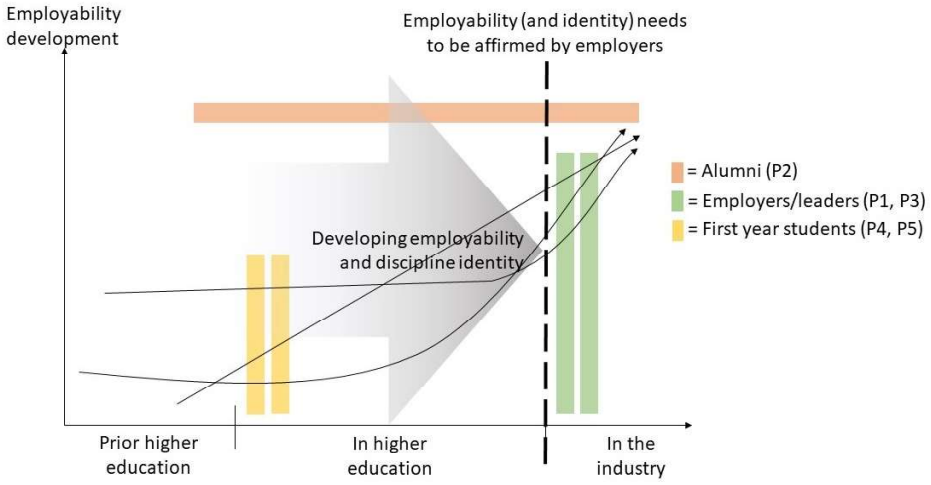

Figure 6.2: Illustration of where the papers fit in students' employability development process

Findings in this PhD project have shown that the development of employability would benefit from being viewed as an ongoing process in higher computing education. The process to develop employability and a discipline-specific identity already starts from the first year at university (P4 and P5) and continues throughout the education (P2). When graduating, students show a "here and now" picture of their employability (P1). After starting their work-life career, graduates continue their employability development process (P2, P3). Although pre-university students were not included in the research in this thesis, it is assumed that employability development starts before entering HE, as students can have previous work experience, and hobby activities; further, their disciplinary identity formation is already ongoing.

This contribution gives **theoretical implications**: employability development should be researched as an identity development process, and not just as a precise goal at the end of higher education. This affects how employability research should be conducted. Instead of seeking the right set of skills or knowledge a student should possess, or using a snapshot of graduate achievements, researchers should be focusing on the process of becoming. Here, an important focus area should be to investigate whether higher computing education gives students the tools for continuous identity and employability development.

6.1.5 RQ3

RQ3: *What can higher computing education do to facilitate students' employability development?*

This thesis has investigated how higher computing education can facilitate students' employability development. It has provided insight into the importance of industry collaboration, providing curricular activities fostering employability development, and addressing matters of diversity. We have four main recommendations for how higher computing education could better facilitate students' employability development:

1. **Close industry collaboration:** For higher computing education in general, collaboration with industry is essential. This can make students be aligned with the discipline during their education. By engaging in activities that are meaningful for their future profession, students can more easily be enabled to imagine and prepare for a future in their profession. Students who are perceived as competent in their class community may not be competent in their discipline if the gap between higher education and industry is too large. A big gap between higher education and industry will result in a hard transition to employment, as well as a long training period after the candidate has been hired. On the other hand, close industry collaboration can result in curricular decisions made in collaboration with industry, making students more familiar with their future possibilities.

2. **Curricular activities:** Higher computing education should provide curricular activities closely related to work-life so that students get experiences related to the discipline's practices. Through these discipline-specific curricular activities, students should become familiar with the rules, practices, and norms in the discipline community, so that they can become aligned to the discipline through engaging in these curricular activities. In addition, higher computing education should focus on community building within the class or study program. We found that having a dedicated area allocated to the class, referred to as an "identity area," where teaching, assignments, teamwork, and extracurricular activities take place, is beneficial in helping students to feel that they belong to a community.

3. **Hobby activities:** By understanding that employability development is a process, higher computing education should facilitate opportunities for students to develop employability during curricular activities and also to encourage students to engage in extracurricular and hobby activities. If higher computing education creates synergies between students' development of

curricular and extra-curricular activities, students will be able to understand why these activities will help them develop their employability.

4. **Including diversity:** This point can be considered from an equity perspective and a belonging perspective. For the latter, higher computing education should be aware of a possible lack of societal perspectives in their education. There tends to be a narrow view that sees strong programming skills as synonymous with disciplinary excellence, as students tend to regard programming skills as a trademark of disciplinary excellence [2]. Having a societal perspective can make it easier for a more diverse range of students to feel that they belong in the discipline, for instance, those interested in pursuing a vision of social change. When viewing diversity from an equity perspective a focus on retention might be important; to research who is dropping out from the computing study programs in Norway, and what can be done to help them graduate. Students should be able to imagine their future through seeing and meeting role models at university or through university held guest lectures with industry (this could be relevant for issues of ethnicity or gender). The curricular activities related to employability development should be held so that students who is restricted from participating at evenings could join (this could be relevant for students less fortunate who need to work to be able to study, students newly moved to Norway who participates in e.g., language courses, or students with family where they are the caregivers), as well as students with disabilities. Facilitating synergies between hobby and curricular activities should not exclude those without hobbies but encourage students to explore and become interested in their discipline.

6.1.6 Contribution 3

C3: *Contributed to the higher computing education research field in the form of practical guidelines for teachers and educational leaders on how higher computing education can emphasize students' development of employability.*

The research for this thesis has been performed in a computing education environment in Norway. The practical implications presented in this thesis are valid for higher computing education in Norway and could be transferable to higher computing education in countries that present a similar context. This entails the production of highly employable graduates who enroll in study-program-specific courses from their first year and are hosted by a department that collaborates closely with the industry. See section 2.2 and 4.3.1 for detailed descriptions of context and employability research in Norway.

Many of the findings and implications presented in table 6.5 are explored in the

current literature on employability. However, the importance of combining these together to get a comprehensive and holistic approach to employability is illuminated through applying the framework of modes of identification as a lens.

By using modes of identification, we have identified guidelines for employability facilitation for teachers and educational leaders in higher computing education. We will describe these guidelines in table 6.5 and explain why they are important when seen through modes of identification.

As presented in table 6.5, this contribution gives **practical implications** for how teachers and educational leaders in higher computing education should facilitate employability development.

Guidelines	Importance through MOI
Make room for teachers to participate in the discipline community	Being involved in the discipline community, teachers are familiar with the practices, repertoire, and competence valued in the workplace, and how they can be role models for students.
Ensure that the curriculum is updated	This makes the gap between education and employment smaller, if students are familiar with the new knowledge in the discipline.
Make sure to present diverse perspectives and role models for students	Be sure to present and introduce different perspectives and role models so students can be aware of the possibilities and imagine their future.
Facilitate reflection opportunities involving students' identity development	Important for students to be aware of the competence gained both at the study program and outside of the university and how this connects with their past, present, and future.
Have close industry collaboration; guest lectures and feedback on the curriculum	Through meeting with the industry, students get aligned with the discipline; by ensuring that the curriculum is known and approved by the industry, the gap between higher computing education and industry can be understood by both parts, and possibly decreased
Facilitate learning opportunities closely related to work-life	Through projects with industry partners as 'customers', and students working in teams, students get aligned with the discipline, engaged in activities closely related to the discipline's practices, and become able to imagine their future.
Encourage hobby activities, give examples of what students can do, and why it is beneficial	By encouraging students to engage in hobby activities, students become familiar with the discipline through other communities, establish a contact network, and broaden their experiences through other people's narratives.
Give room for developing interest in the discipline through extracurricular activities	By providing identity areas, making technology available, and suggesting extracurricular activities for students, educators can help students increase their employability and possibly also boost their university achievement

Table 6.5: Guidelines from paper 6 for teachers and educational leaders in higher computing education on how to facilitate students' employability development, and why these guidelines are important, as seen through the lens of modes of identification

6.1.7 Main research question

The main research question was:

> *What characterizes students' employability development in higher computing education, and what can be done to facilitate employability development in higher computing education?*

To address this overarching question, the thesis has answered three research questions and made three contributions. We have seen that the lens of modes of identification offers a different perspective on employability, where identity formation through alignment, engagement, and imagination have been the focus. This lens has shown us that close collaboration with industry is important for universities pursuing the high employability of their candidates.

Employability is characterized by several factors. We have seen that surrounding people, role models and their narratives are important for employability development. Close collaboration with the industry is beneficial for students' alignment, engagement, and imagination. Hobby activities could validate some of students' employability development, and can also make students familiar with practices, repertoires, and activities meaningful for the discipline. There is also a need for diversity, to make a wider range of students feel they belong in the discipline, and to enable them to imagine a future within the discipline. Lastly, by viewing employability as a process, we see that students need to learn how to continuously develop their employability, also after the completion of higher computing education.

We have developed a set of guidelines for what teachers and educational leaders can do to facilitate student employability development in higher computing education. These guidelines argue that projects simulating employment projects and situations give students useful experiences appreciated by the discipline community. Close collaboration with the industry, e.g., through guest lectures, may provide diverse role models and perspectives for students to align to, making it easier for them to imagine their professional future.

6.2 Evaluating the research

In this section, I will reflect briefly on the project in regard to generalizability, validity, and researcher reflexivity, including the researcher's role in the context/institution of the research. Next, reflections on ethical considerations are described, including informed consent and confidentiality, before the section ends by addressing limitations to the project.

6.2.1 Transferability

As the research method used in this thesis is mixed, but with its primary grounding being in the qualitative paradigm, the generalizability is referred to as transferability, where the reader has the responsibility for defining if the context (described in sections 2.2 and 4.3.1) and the findings are transferable to his/her situation [8, p 57].

As this thesis has researched computer science students and graduates and the employers hiring these students, it is our aim that the findings of this thesis will be transferable to the higher computing education context. The implications outlined in the thesis should be beneficial for computer science teachers, study program leaders, and those in charge of developing the computer science curricula in higher education.

The study programs investigated in the empirical research were all from the same university (NTNU). To make the findings transferable for the higher computing education field, I have selected different study programs to investigate. These study programs are different in terms of level: both bachelor's study programs and a master's study program (see table 4.1 for elaboration) were researched; I included both theoretically oriented and more practically oriented study programs, and there were both on-campus and online study programs included. This mix of study programs gives a representative view of computer study programs in Norway. In interviews with employers, they were asked to talk about the study programs in question. As they were hiring graduates from other universities in Norway as well, they were often found to be comparing the study programs in question to other study programs in Norway, and thus relating their answers to many higher computing education programs in Norway.

This brings us to the next issue: the study programs were all located in Norway, and the participants and informants were Norwegian. It is reasonable to suggest that as the terminology, definition, and frameworks used in this thesis are international, the theoretical contributions might be transferable to other countries in the Western world. Through accepting the dissertation's papers for international conferences and journals, the academic community has indicated agreement that this research is of international relevance.

The study programs investigated were all within the field of higher computing education. I argue that the findings and contributions may be transferable to higher education in general, as the concept of employability is being used and understood in a similar way within several disciplines. Seeing employability through an identity formation perspective with alignment, engagement, and imagination as a lens

can make higher education in other disciplines discover relevant challenges and problem areas connected to employability development for their students. When it comes to the practical contributions of the thesis, some of them can be considered as transferable to higher education in general. Having close collaboration with future employers, decreasing the gap between higher education and employment, and thinking that students continue their future employment within the same discipline, could benefit the students in diverse study programs. Also, having learning opportunities closely related to work-life would make students prepared for their future. Having holistic reflection opportunities involving hobby activities, curricular activities and students' identity formation would make students aware of where they have been, where they are, and where they are going in terms of employability development.

6.2.2 Credibility and legitimation

In mixed-method research, the combination of qualitative and quantitative research challenges the researcher, as different terms are used to discuss validity. Validity is *"a matter of trustworthiness, utility and dependability that the evaluator and the different stakeholders place into it"* [97]. However, the word 'validity' is more often used in the quantitative research field, in which the researcher seeks to understand whether instruments measure what is intended to be measured. In qualitative research, the word *credibility* is often used. Qualitative research seeks to establish whether the results are credible or believable [8]. Onwuegbuzie and Johnson [61] argues that we should use the word "legitimation" for talking about mixed-methods research and presents nine different legitimation types: sample integration, inside-outside, weakness minimization, sequential, conversion, paradigmatic mixing, commensurability, multiple validities, and political. Those relevant for this thesis are:

Sample integration: The threat is related to how the sample was selected, and how these different sets of people can be combined. This thesis has samples from three main sources: students, employers, and alumni (see 4.3.2 for deeper insights to the samples). These three groups of samples are used for illuminating employability in higher computing education from different sides. Having only one of these three groups would have created results that might not have shown the whole picture. This was particularly true of the alumni group, which was only researched once. To accommodate this threat, this group had the biggest sampling size. The informants were selected differently according to their group: Students and alumni were recruited through a 1:N request broadcasted by the study program leader or by email. There is a risk that these students were extra positive or negative towards the study program. For P2 with alumni, the results were insufficient for substantiating any conclusions. To accommodate this, a survey was held, inviting

all alumni having graduated within the last 8 years to answer. For P4 and P5, interviews investigated students' own future prospects and their understanding of the discipline and class community. Whether they had a positive or negative attitude toward the study did not, therefore, threaten the results, as it was their personal development that was the focus. Employers were recruited through 1:1 requests to participate. To make sure that these employers hire from the study programs at focus they were chosen by the study program leader (P1), or they were members of a formal industry network connected to the university departments and thereby known to be companies hiring regularly from the study programs in question (P3).

Inside-outside: The threat is whether the researcher presents both an insider and an outsider view, as important points might be missing without both views. This threat has been avoided by having close collaboration between study program leaders (insiders), and researcher (outsider). The study program leaders have been authors (P1, P2) or conducted questionnaire surveys (P3). The research, analysis, and writing for P4 and P5 were undertaken without the study program leader participating; however, the ideas were discussed collectively beforehand. As I have been employed through this PhD project on the faculty which offers the study programs included within the scope of the research, one could argue that I also had an insider view of the research. Still, I did not know the students, the alumni, or the employers beforehand, and I did not teach at the study programs researched. Thus, I would argue that I have an outsider view of the research. In addition to this, the outsider view was to some extend ensured by having informants who are definitely from the outside of the university: employers and alumni.

Sequential legitimation: This threat is related to the sequencing of the research. The question is whether the results and interpretations would have been different if the order of the quantitative and qualitative research were reversed. In this thesis, I have used exploratory research, where the findings from the qualitative investigations have informed the quantitative method. It is natural that the results would have been different if the sequence had been reversed; the quantitative research might have been conducted differently, i.e., with different questionnaire items, which could have led to different results. For papers 2 and 3, I chose to have the qualitative method come first, as I was more confident in an interview setting. Paper 2 originally did not plan to include a quantitative method, but due to inconsistent findings from the qualitative method, there was a need to look at a broader population. Paper 3 added the quantitative method to confirm the findings from the qualitative method.

Conversion legitimation: In this project, the qualitative results have on some occasions been categorized and counted to provide a quick overview for the reader, which might have led to 'misleading counting" [72]. In paper 1, where a mixed-

methods approach was not used, the qualitative data have been quantified to create an overview of the results. As the number of informants was small (10 employers), the counting might have led readers to think the results were quantitative or based on a larger number of participants. However, it is stated throughout the paper that the results came from interviews. In paper 3, some open-ended questions from the questionnaire have been explored and used as a more qualitative result. As the participants have been writing these comments themselves, I cannot see a problem with using the open-ended answers as qualitative sources.

6.2.3 Validity threats for an exploratory sequential mixed-methods design

This thesis predominantly relies on qualitative data collection. For the two studies including quantitative methods, exploratory research was conducted (P2, P3). According to Creswell and Plano Clark [21], there are three validity threats to avoid when conducting exploratory sequential design in mixed-methods research:

1. Not building the quantitative feature based on the qualitative results. For P2 and P3, the results from the interviews were coded and the findings gave insights that were used when forming the questionnaire. The quantitative analyses in P2 and P3 were added for complementary reasons, i.e., to understand or clarify the qualitative results.

2. Not developing rigorous quantitative features. For P2, the questionnaire used a framework developed and tested by Jackson and Wilton [40] on Perceived Employability. For P3, the questionnaire was developed by the study program leader Knut Arne Strand and the co-author Birgit Krogstie. The questionnaire went through several iterations to make the questions clear, understandable, and non-leading; this proves involved the other two authors as well. Both questionnaires were tested out on employees at the department before being sent to the participants.

3. Selecting participants for the quantitative test that are the same individuals as the qualitative sample. In P2, the informants and the participants were from the same pool of people, and some of them might have participated in both rounds of data collection. This can make the results less reliable, as the participants in the quantitative part respond on a different basis; some have already participated in the interview, and possibly got time to reflect on the questions. For P3, there was no overlap between informants and participants, as the questionnaire was not sent to those who had been interviewed.

6.2.4 Researcher Reflexivity

Reflexivity is about identifying preconceptions brought to the project by the researcher. This could be the researchers' experiences, perspectives, motivation, or qualifications within the field or as a researcher [51].

My motivation for conducting research within this field was initially related to a wish to improve computing education and to make students ready for employment. During the PhD project, there has been a change in my view on the concept of employability. The first paper (P1) focused on employability as skills, knowledge, and personal attributes, and the second paper (P2) focused on self-perceived employability, before the employability view changed to become identity formation oriented. Including an identity view on employability led me to explore communities of practice and the modes of identification, which consist of alignment, engagement and imagination. Discovering that students need to be able to see themselves in a discipline-specific job in the future and have enough knowledge to align themselves to the discipline was an eye-opener for me. It made sense of my personal experience when graduating from a computer engineering educational program. I had the right skills, knowledge, and personal attributes sought by employers, but I did not identify myself with the discipline, and I could not imagine myself in a future computing job. This lack of disciplinary identity led me to not apply for such jobs. According to my first understanding of employability, I was employable, but according to my current view on employability, I was not employable. I saw that my experience as a computer engineer was related to identity formation, and the idea that employability and identity were closely connected became even stronger.

Even though there was a change in my perspective on employability after my work on the first two papers, these papers pointed towards the change: P1 argued that there is more to employability than skills as hobbies were an important issue for employers, and P2 argued that employability is also closely related to one's contact network and understanding of the discipline (knowing if your competence and experience is sought after). The change in employability view does not make the results invalid. Perceived employability (used in P2) could have been used further in this PhD project, however, this concept does not address why students perceive themselves as having a certain level of employability, which is of interest to this PhD project.

Researcher's Role

When interviewing the informants, I presented myself at the beginning of the interview. My own educational background was addressed in this presentation so that informants knew my competency when discussing or talking about technical terms

When	What	Who
2017	One summer job applicant	Transcribed interviews, some analysis
2018	One summer job applicant	Transcribed interviews, some analysis
2018	Two student assistants	Interviewed for paper 3, transcribed interviews
2019	Several student assistants	Transcribed interviews

Table 6.6: Overview of external resources this project has used, for what and when

or presenting their view on the study programs. I had been clear that their conversation with me will not be discussed outside the interview setting with others at my department, but it would be used in research.

My duty work associated with my PhD has included both supervising bachelor's students and teaching two courses. However, the student groups participating in the research did overlap with the students I supervised or taught.

Before researching students or employers/alumni, there was an initial discussion with the program leaders of the study program. The study program leaders have participated as co-authors of the research papers, or they have discussed what to include in the interview guide and questionnaire. For conducting and transcribing interviews, the Excited center has provided resources in the form of student assistants and summer job interns (see table 6.6).

The former College of Southern Trøndelag (Høgskolen i Sør-Trøndelag (HIST)) initially funded this PhD project. When the college merged with The Norwegian University of Science and Technology (NTNU), the "Department of Informatics and E-learning" from HIST was merged with the "Department of Computer Science" at NTNU but continued as a separate sub-group. This group, now known as Applied Information Technology (AIT), has close collaboration and social connections amongst the members. This has helped me in contacting and collaborating with teachers and study program leaders.

The project has been conducted in collaboration with the Excited Center for Excellent IT Education. This collaboration has given the project better outreach and let me be a part of a research group. When I started my PhD journey, I was the only PhD student in the AIT group, and the Excited group has provided an environment for good discussion. Both at AIT and in the Excited group, several PhD students joined after me.

6.2.5 Ethical concerns

In general, there are several ethical considerations to consider when doing research: informed consent, confidentiality, consequence, and the role of the researcher [47]. Prior to the data collection, I applied and got my research and data storage plan accepted from NSD. When reaching out to informants, I presented the project in e-mail or orally. If they consented to participate in the study, I sent them a consent form, which had to be read through and signed before the interview. The form contained information about the right to withdraw from the study at any time, the purpose of the study, and the consequences of participating in the study. All the informants have been anonymized. Students were informed that participation in this research project could not affect informants' grades, and alumni and employers were told that participation would not affect their career.

6.2.6 Limitations

The research presented in this thesis has some limitations. The first limitation is the number of informants. The aim was to interview 10-12 informants in each round of data collection; however, the number of informants varied from six to ten. For the quantitative part of paper 2, the response rate was 38,7% of the population, while in paper 3 the response rate was 20%. Even though the number of informants could have been higher, the results in this thesis would likely have been the same: we reached saturation in the analysis of the data [73].

The second limitation is related to the research context. The research was conducted in the computer science department of the Norwegian University of Science and Technology (NTNU). The results could have been different if the research had been conducted across universities or across countries. However, conducting the research in one department made it possible to research different computing study programs with similar contextual environments. Based on research on different types of study programs, the results are transferable to many types of study programs and are not bound to, e.g., engineering study programs.

A third limitation is related to employability development and identity formation. Papers 4 and 5 research employability development for first-year students, and paper 5 argues that students at that point have started their identity formation. As this is their first year in higher computing education, the results do not show the whole picture from starting higher computing education, through their education, and into employment. To compensate, we have interviewed alumni and employers to understand how they see employability development from their point of view.

Chapter 7

Conclusion

7.1 Concluding remarks

This thesis aimed to enhance the understanding of employability and get a deeper insight into students' employability development. Through new knowledge on employability development, the aim was to improve higher computing education. Using qualitative research and mixed-methods research, I have investigated employability and its development from the perspective of students, alumni, and employers.

I found that employability could be viewed through a Communities of Practice perspective as closely related to identity formation. I used 'modes of identification' by Wenger-Trayner and Wenger-Trayner [91] as a lens on employability, finding this to provide a richer approach than the traditional view on employability where competence is in focus. This allowed me to investigate students' ability to imagine their future, align with their discipline, and engage in meaningful activities valuable for the discipline.

There was a need to look into what factors influence students' employability development. Here I found that people, hobbies and interests, and students' view of each other as misfits had a significant impact. Taking a process view aids the understanding that employability is developed not only during higher education, but also before, after, and outside of higher education. This enhanced view gives hobbies and interests the credit they deserve as contributors to employability development. It also guides researchers towards a more holistic approach, more easily recognizing that employability development can also happen through conversations and activities outside of the university. It allows for researching employability also

after graduation, as development continues during the work careers.

Even though employability development continues after graduation, this thesis has focused on what higher computing education can do to facilitate students' employability development. I found four main points important to consider: 1) Having a close industry collaboration, 2) Curricular activities closely related to work life, 3) Encouraging students to develop an interest or hobby in the discipline, and 4) Have diversity in perspectives and role models presented for students. The thesis presented guidelines for teachers and educational leaders on how they can facilitate employability and why the guidelines are importantly seen through the lens of modes of identification.

7.2 Future work

This thesis gives insight into how employability can be researched in the future by suggesting modes of identification as a framework. Future research could use this framework on study programs outside of Norway and in other disciplines.

Due to time constraints, this thesis has only investigated employability development for first-year students and argues that students have started their disciplinary identity formation during this period. As this is their first year in higher computing education, one could gain new insight into employability development by following the students throughout their education and employment. Future work should follow students from their first year in higher computing education, through their education, and further in their employment to explore how employability develops as an identification process. This should also be done to study programs outside of the computing discipline to see if there are similar findings in other fields as well.

As the guidelines for teachers and educational leaders in this thesis have been developed through implications from findings in papers 1-5, future research could perform validation studies where the guidelines are actually used in redesigning or improving study programs, to examine whether these lead to actual benefits for students' employability development and how to further develop the guidelines.

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Part II

Research Papers

Paper 1

The Employer Perspective on Employability

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EDUCON 2018

The Employer Perspective on Employability

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***Abstract*—Employability is a term used for describing the skills, knowledge and personal qualities a graduate should possess to get a job. In this paper we suggest what these skills and qualities are for IT undergraduates specializing in network administration. We have interviewed 10 recruitment managers from 9 different companies who have employed candidates from an IT network administration study program. They suggest that personal qualities are the most important aspect they look for in the graduates. We found that several of the recruiters want the graduates to have an interest in technology also outside of the curricular activities or work setting. This type of interest is taken as a sign that the graduate/job seeker is able to employ their knowledge in practice and engage in continuous self-development and lifelong learning, validating their employability. We discuss how the university can cater for curricular as well as extra-curricular activities, thus leveraging as well as developing the interest in the field valued by employers.**

Keywords— Higher Education; Employability; Interest; Undergraduates,

I. INTRODUCTION

An important issue in Higher Education research is what it means to be ready for employment. The primary goal for a university is to educate students so that they can start working after ended study. Also for the graduate the goal is often to be able to acquire a certain job within a specific field. Being ready for a career is often referred to in the literature as employability.

The term employability is used with no clear agreement among authors of what is actually included [1]. The employers seems to value different skills and attributes, and that there is no consistent use of terms used for describing these skills and attributes[2]. Most papers try to split employability into several categories, before defining what is included in the term. Employability can be split as skills and knowledge, without the personal aspect[3], while other split employability in categories like "Personal qualities and people skills, professional knowledge and skills, and technology knowledge and skills"[4]. Employability has also been defined as a combination of basic knowledge/skills and applied skills, Where basic knowledge/skills is fundamental, the applied skills are seen as much more important to be successful at work [5]. Some skills are more commonly cited than others, like communication, team working, information technology and planning and organizing. The personal attributes that occur most often in research on employment include flexibility, adaptability, hardworking, commitment and dedication [1].

In this paper we use the term employability as: "a set of achievements, skills, understandings and personal attributes, that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy" [6]. We understand grades or experiences you could put in the diploma as achievements, while skills are interpreted as something a graduate can gain by practicing or training. Understandings explains what a graduate should comprehend, whereas personal attributes are characteristics about a person that are relatively constant. Personal attributes is also seen as inherent and not teachable in a employability study for recently graduated computer programmers [7].

In addition to skills and personal attributes, engagement is seen by some researchers to have a connection to employability. "We are left with the clear impression that the weight of argument and evidence supports the view that Student Community Engagement has a positive impact on student employability, at least initially" [8]. Another study argue that inner drive and interest in the field is one of the most important qualities to have for a graduate computer programmer to be attractive for a IT company [7].

The Higher Education Institution (HEI) facilitates opportunities for the graduate to develop employability through 1) development of attributes (important in obtaining, keeping and developing jobs or careers), 2) self-presentational skills (important when seeking jobs) and 3) encouraging a love of learning and a willingness and awareness of the need to continue learning [9].

Curricula or experiences alone do not make a graduate develop a high degree of employability. "The curricular process may facilitate the development of prerequisites appropriate to employment, but does not guarantee it. Hence it is inappropriate

to assume that students are highly employable on the basis of curricular provision alone: it may be a good harbinger, but it is not an assurance of employability. Employability derives from the ways in which the student learns from his or her experiences" [6]. Experiences outside the curriculum and the HEI may have an effect of the employability of the graduate [6].

[9] argues that the graduates themselves need to take actions to use these opportunities offered by the HEI to become more employable, and they can also increase their employability by engaging in activity outside of the HEI. This include students' previous experience, their extra-curricular activities, their career intentions and networks, and the quality and availability of the employability experience within the institution, particularly that which is integral to and explicit in their program of study. Employability skills are only partially contingent on what is provided by the institution [9].

To illustrate the situation today, as described by the literature, Figure 1 was made. There the HEI provides curricular activities that the graduate can participate in. These activities increase the employability of the graduate, which include the four aspects described by [6]. The graduate can also participate in extra-curricular activities, e.g. student community engagement, which also affects employability.

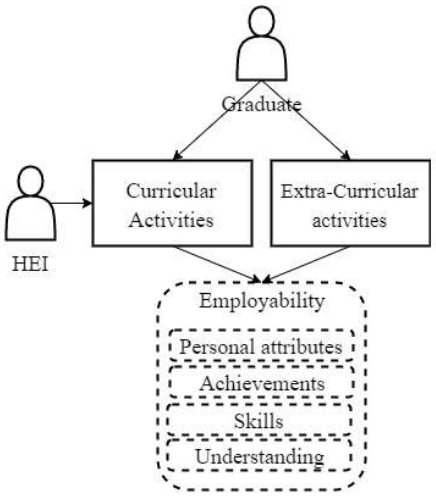

Figure 1: Employability deriving from curricular as well as extra-curricular activities

On this background, this paper explores how the employability of graduates in IT Network Administration is perceived by employers, what skills the graduate need to possess, which personal qualities the students need to get employed, and whether these qualities result from curricular or other activity. In this case the term graduate refers to undergraduates. Also, we discuss how the desired employability can be fostered by the higher education institution.

II. CASE

The study program selected for this case-study was established as an informatics bachelor program in 2005 and has consistently received good reviews in surveys among post-graduates. The latest candidate survey indicated that IT Network Administration candidates were more likely to gain employment after graduation than students from comparable study programs within the institution. The perception that these candidates are attractive is also bolstered by the amount of activities that are arranged by potential employers for the senior students, such as presentations and pre-graduation interviews. The hypothesis among the teaching staff at the university has been that these candidates are attractive because of a high degree of collaboration with external businesses and a focus on student-active learning methods. The curriculum has been adjusted frequently according to market demands, and a high degree of team-based practical work has been implemented with a teaching staff focused on upcoming trends within the field. An example is the use of virtualization technology that was implemented in 2008 both as a platform for students' lab-exercises and as part of the curriculum in classes. The study program is based on early implementation of new products and services with updated product versions of operating systems, management systems, virtualization platforms, and cloud services. Several partnerships with providers of both software and services has been instrumental to achieve this learning environment.

During their first semester students are required to work with projects in teams with simulated real-world exercises and present their findings and results to the rest of the class. This method of learning is also used in the second and third year, where several of the grades are based on team achievements. During their second year each team has responsibility for their own physical server. This is their primary platform for lab-exercises, and teaching staff only interacts with the server in cases where there are problems. Thus, the learning activity is characterized by a high degree of independence on part of the students. Furthermore, this server is adjacent to a so-called identity area dedicated to students in this particular study program, so that students are able to interact with the equipment outside of the HEI schedule (see Figure 2). With this approach students are not bound to one strict way of providing services, but instead have the means to find their own solutions. In order to facilitate this the teaching staff in such classes typically organize sessions starting with the teacher giving a short introduction to the subject. Then the teacher spends the rest of the session collaborating with the students in their problem-solving to achieve the learning outcomes for that session. This approach to teaching has been implemented in order to cultivate social skills that are typically sought after by industry, such as teamwork and oral communication gained from collaborative project-based work methods [10].

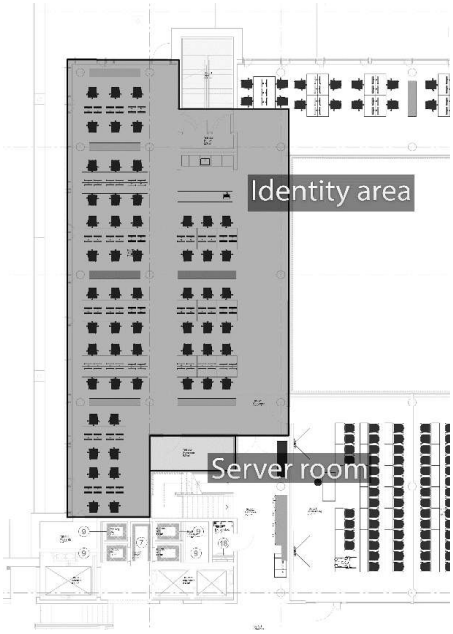

Figure 2: The identity area and the nearby server room

Individual courses are adjusted regularly, and there have also been several revisions to the study program as a whole. The latest full revision was implemented in 2012. Since then there has been a recent consolidation where the university merged with three other academic institutions. As part of the ongoing activities related to horizontal and vertical alignment of programs and courses the bachelor program will undergo a new revision. This will be founded on an evaluation initiated by the faculty, input from teaching staff, former and present students, the upcoming ACM IT2017 curriculum, along with fresh input from industry. As part of the data collection from external partners, the department hosting the study program decided to do a thorough evaluation, both to assess the quality of the teaching activities, and to ensure that future graduates are attractive among employers. This coincides with the goals of a nationally funded Centre of Excellent Education, also managed by the department, for which one of the focal areas is to investigate and improve the collaboration among educational institutions and industry.

There is no formal alumni group for this specific study program, but several of the teaching staff maintain contact with former students. This is done to gather information, e.g. through surveys, about what skills and attributes are their current employment demands. We thus know the demographics of the type of organizations that have recruited candidates in the past and are likely to do so again. There is a variety of positions taken by the candidates among various employers, but the common denominators are that all candidates are employed nationally, and the majority are concentrated in the SMB-segment[11]. We have found several former students working in roles without any obvious relations to their former classmates, but an apparent majority are working alongside other candidates from the same study program in organizations that have IT as a part of their core business. Regarding positions the vast majority are employed in technical positions, typically as some form of IT-administrators or IT-consultants, with some having transitioned to related positions such as systems advisor, analyst or architect, and various management roles. It is also worth noting that very few candidates had opted for further academic progression, with only a handful found to have progressed to a master degree.

III. METHOD

The interviews addressed the following overarching research question: "What makes a recruitment manager employ an IT Network Administration graduate?". The study was designed as a "common-case" rationale in a single case, where we aim to capture the circumstances and conditions to answer this question[12].

Among the selected organizations several have their main office in the region, but only one had restricted their operations to the region, and two had no local office at the time of study. There is no known recruitment internationally from the study program, but six of the organizations have international operations. Three of those organizations also exceed the size definition of SMB, but their national office where candidates have been recruited, is consistent with this denotation (see Table 1).

Participants in the study were selected from organizations known to have repeatedly hired candidates from the chosen study program. Restricting the selection in this manner ensured that we would get informants hiring candidates on the basis of some knowledge about the education provided through the program. In order to get informants more likely to have knowledge about the labor market, field, and recruitment in general we opted for organizations of a certain size (SMB-size), leaving out one-man enterprises and small startups. From the selected organizations participants were invited among department leaders or HR-employees with the criteria that they

Type of business	Organization size	Organization location
Recruitment and consulting	1000 > (internationally)	International
IT-consulting	500-1000	International
IT-Service provider	250-500	National
Service Provider	> 100	National
IT-Services and consulting	1000 > (internationally)	International
IT-Service provider	100-250	National
IT-Software and service provider	250-500	International
IT-Service provider	250-500	International
IT-Service provider	250-500	Regional

Table 1: Overview of selected organizations

Informant #	Type of position	# of years involved in recruitment	Length of interview in minutes
1	Business Manager	6	44:20
2	Community Leader	>1	35:41
3	Section Manager	5	48:05
4	Section Manager	10	44:08
5	Team Leader	7	27:38
6	Section Manager	5	39:08
7	Business Manager	2	48:13
8	Department Manager	2	29:31
9	Knowledge Manager	16	36:39
10	Consultant Manager	10	45:55

Table 2: Informant position, recruitment experience and interview length

are decision-makers in the recruitment process. Initially 11 invitations were sent to 11 different organizations, and this resulted in a total of 10 interviews with informants from 9 of the organizations. Workforce turnover also played a part in the final composition of the group of informants, as two informants had recently found new employment, moving from one of the target organizations to another. For this reason, two informants were selected from one of the organizations, as one of the informants had extensive insights from another organization that was not otherwise represented. An overview of the informant positions and experience with candidate selection can be found in Table 2. Note that informant 6 was accompanied by a representative from HR during the interview, and the data analysis was done with input from both informants. The table only lists the Section Manger, as this informant had the closest relation to the subject of this study.

Qualitative data was collected through individual, semi-structured interviews with the informants listed in Table 2. The interview guide was designed to make sure the questions were open and did not leave any guidelines or hint for the answers. Questions like "What is the ideal job seeker" and "What kind of knowledge, skills and personal attributes do you look for when you have a hiring process" were asked, and to encourage more elaborate response, the interviewees were asked to reflect on their answers.

The interview guide was approved by all three authors. The interviews were conducted by the main author to ensure consistency in the way the questions were asked.

To analyze the findings two of the authors and a research assistant read all interviews and coded four of them together to establish intercoder reliability. The rest of the interviews were coded separately but with overlap, so that each interview was coded by two people separately and their coding subsequently compared. Since the codes emerged from the material, the process was iterative, going from text-based coding to categories[13].

IV. Results

During the interviews, the informants mentioned many different characteristics that they looked for when hiring a candidate. Due to the semi-structured format and open-ended questions there is a wide variety in the characteristics mentioned. An overview of the characteristics that were referred to by the informants is presented in table 3. We have sorted the characteristics in descending order based on how many of the informants mentioned them, see column "#informants". To improve readability the characteristics are organized according to the definition of employability by dividing them into Skills, Achievements, Understandings and Personal Attributes[6].

A categorization of which informant has mentioned what aspect, and the number indicates how many times each

		Informant 1	Informant 2	Informant 3	Informant 4	Informant 5	Informant 6	Informant 7	Informant 8	Informant 9	Informant 10	#informants
	Interest in the field	17	5	4	1	5	1	13	9	1	1	10
Understandings	Organizational understanding	6	2	3	10	2	3	6	1	11	3	10
Skills	Oral Communication Skill	5	2	8	2	3	2	6		5	1	9
Achievements	CV/diploma	8		1	1	1	2	5	1	1	2	9
Personal attributes	Reliable, Responsible	1	5	1	4	3	2	2		3		8
Skills	Teamwork	2	2	6	7			2	2	1	5	8
Personal attributes	Outgoing	1	3	4	2	1	1			1	1	8
Skills	Lifelong Learner		3	3	8	1	3		2	2		7
	Scripting /powershell		4	2		1		3	1	1	1	7
	Problem-Solver			1	4		1	4	1		5	6
Personal attributes	Self-driven	2	1			1	2	2	2			6
	Attitudes			1	6	1	1	2		3		6
	Sociable	2	1	1					3	2		5
	Shows initiative						3	2	2	1	1	5
	Curious	1		1			2	2			3	5
Skills	Cloud services	3	2	1				1	1			5
	Virtualization	3	1	1		1			1			5
Personal attributes	Flexible		1	1			3	1				4
	Consultant		3	1		2		2				4
Skills	Azure	1						1	2		1	4
	Linux	2	1			1			1			4
	Written Communication Skill				3			6		4		3
Personal attributes	Structured			1		2				1		3
Achievements	Bachelor thesis					1	1				1	3
Skills	ITIL			1	1					3		3

Table 3: Overview of which informant has mention which characteristic, and number of times they mention each. Sorted by how many informants that spoke of each characteristic. Categorized by the definition made by [6].

informant has mentioned the aspect (see Table 3). To be counted as "mentioned", the word/phrase had to be mentioned explicitly by the interviewee, or he/she used a synonym.

When we summarized the aspects in this manner we found an apparent consensus among all informants on two aspects that are emphasized during the employment process, namely "Interest in the field" and "Organizational understanding".

As can be seen in the leftmost column in Table 3 the aspect "Interest in the field" has not been assigned to any of the four aspects of the employability definition. The informants referred to this as an underlying aspect that could enhance and validate other aspects and provided a platform for good workplace performances. One of the informants explained how this characterizes the preferred candidates:

Informant 3: "*The very best, you know, are those that have IT as both a job and a hobby. Those that sit at the dorm, or wherever, being inquisitive and exploring… making stuff on their own. Those are the very best, those who have that burning interest that we are always in demand for. Then there are those that treat it like a job and do their job before they put it away and go home. That's okay, as long as they do a good job. But they will never be as good as those that have IT as a hobby*".

How this aspect can go beyond the curricular activities is illustrated in the following quotation:

Informant 7: "*Some have learned in school, and we see that we prefer to hire those that sit down and… that they have tested and tried and played around. To get a deeper understanding, more than a few hours per week during a semester before the exams and then be done with it. […] There are several of those things that you need to have, you need to have tried it for yourself*."

Another example of the importance of this aspect and how it is perceived to improve workplace performance is this quotation from one of the informants:

Informant 8: "*Having something as a hobby, it could be just something small, but it's so important that you are interested, because I think you will automatically be good [at your work] and enjoy your work. It's so important. And we have noticed that the students from here [referring to the program] have this interest. They are sitting at home, tinkering [with technology] … they might have done it before the studies as well, it's in their blood. And it… it's important, because, if you have it [the interest], you are going to be very good, and work hard, do a good job and you will enjoy it. That's what we are looking for*".

The other aspect mentioned by all informants was "organizational understanding", which referred to both the ability to perform alongside others and understanding their role in how to achieve organizational objectives. This is illustrated in the following quotation:

Informant 4: "*[…] in today's labor market, […] you have to work more and more interdisciplinarily, and you have to understand companies, and to get this understanding you have to be able to talk with many groups, not only engineers, and people have to think it's all right to work with you. It's not so important how you do it, but you have to see yourself as part of a community*."

Closely related to the ability to perform alongside others is "oral communication skills", that was mentioned by all but one of the informants. Several of them emphasized how important it is to relay expertise appropriately and understandably to clients and colleagues. This was mentioned in the previous quotation, and another informant likened not having communication skills to not having knowledge, exemplified in the following quotation:

Informant 3: "*if you freeze up and become insecure even if you know the answer (…), and you are unable to convey it, then that's as big a problem as if you don't have any knowledge*".

Communication skill was also mentioned as a means to express enthusiasm and pass this on to clients as displayed in this situation:

Informant 5: "*You can tell if people are engaged! [If they] are selling and capable of conveying information about the technology that we are in fact selling and implementing, and are capable to talk to both management and the IT-department, users, in a good way*."

With one exception all informants mentioned academic and professional achievements, i.e. CV/Diploma, as an important attribute. The significance placed on top grades, however, was not consistent among the informants. Several of the informants mentioned such achievements as requirements to get interviewed, but good grades did not necessarily translate to being the preferred candidate, as this quotation illustrates:

Informant 1: "*If you have got an C in average and like to tinker [with technology] in your spare time, that might be better than having a B in average, and don't tinker in your spare time."*

"Reliable and responsible" were the most desired personal attributes among the informants. The importance of these attributes appears to be related to the reliance on IT-systems in modern organizations, as mentioned in this quotation:

Informant 4: "*If your employment is based on systems that need to be available all year you don't want a colleague that might bail on you when things heat up*."

The previous quotation also indicates the importance of function alongside your co-workers, which is related to the "Teamwork" skill. The same informant expanded upon this in the following quotation:

Informant 4: "*You can be extremely good technically, but if you aren't a team player … […] it does not matter. What the school has done, making the students work together in projects and actually helping each other, is an important issue in one's further working life, I think. You don't need fantastic top achievers, you will need people that are very good at working together, especially since things get more and more complex and we all make mistakes*."

Among the remaining attributes the perhaps most unexpected finding was that only three informants explicitly mentioned "Written communication skill", which is only one third of those that mentioned "Oral communication skill".

Considering the overall findings from the interviews, we find that the employers of the IT network administration candidates

look for personal characteristics consistent with what has been found in the research literature on employability, as addressed in the Background chapter. What is particular noteworthy about our study is how the employers stress *interest in the field* as a key characteristic of attractive candidates, and how the employers link this to students' engagement in extra-curricular activity.

In the discussion chapter, we will go into some more detail on the connection between curricular activity, extra-curricular activity and students' interest in the field. We will elaborate on how they can be supported in order to strengthen students' employability, considering the present organization of the IT network administration study program and what can be learnt from it.

A. An extended model

Based on the results outlined in the previous chapter, we made an extension to the model in Figure 1, including students' interest in the field as a separate entity in the model and suggesting that extra-curricular activity play a role not only by contributing to employability, but by validating the employability provided through curricular activity. The model is presented in Figure 3. We will explain the model in what follows.

The graduate is the person of interest, it is him/her that needs to be employed and has a level of employability. The graduate can develop employability through four different aspects: Personal attributes, achievements, skills and understanding. On these aspects, we have employers' viewpoints as explored in our interviews.

1. Personal attributes: The results of our study indicated that these attributes are seen as static by the recruitment managers. They think that what they hire is what they get, and that they cannot change the personal attributes of the graduates. The recruitment managers argue that it is easier to change the graduates' knowledge than their personal attributes, and some argue that they would rather hire a graduate with poor technical skills than a graduate with personal attributes that do not fit the company. Overall, it seems that some characteristics considered by the HEI to be skills that can be acquired and improved (e.g. being structured) are considered as inherent, unchangeable personality traits by some employers.
2. Achievements: According to the informants it is important to have good grades and a diploma when applying for a job. The grades determine whether the graduate gets the opportunity for an interview by the company. The diploma is an overview of what the graduate should have knowledge about, and the grades should indicate how well the graduate have the knowledge / skill / understanding.
3. Skills: Skills are knowledge that you apply to solve a problem or task. This includes technical skills e.g. in programming and system administration, and it also includes soft skills frequently mentioned by the informants in our study, e.g. teamwork and oral communication skills. The HEI aims to develop such skills through project work, which requires the students to learn how to handle deadlines and how to work in teams together with their classmates.
4. Understanding: According to the informants it is important to have organizational understanding. This implies understanding where in the work chain you belong, how it works, that you have the ability to talk to both engineers, other colleagues, and customers with no technical background. You need to comprehend what your job is, and what it is not, so that you don't create additional work for others because you worked outside of your scope and ruined something.

To become more employable the graduate can choose to participate in the curricular activities provided by the HEI. These activities are seen as employability development opportunities for the graduate [9] and include lectures, teamwork, assignments, and other types of learning activities in the course in which the graduate participates. Additionally, the graduate can participate in extracurricular activities which also may contribute to employability.

If the graduate has the interest in the field that so many of the recruitment managers ask for, this makes the graduate more likely to participate in extra-curricular activities including the use of technology they want to explore and master. There may or may not be a connection to what the students learn as part of the curriculum of the study program. As such, these activities represent a way to learn something new but also to deepen the

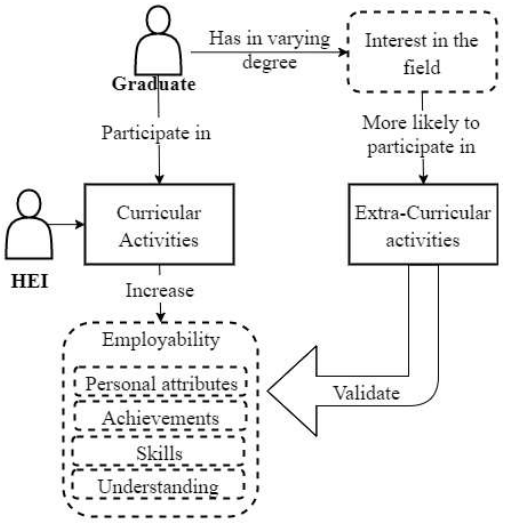

Figure 3: Extended model where interest and validation are shown

knowledge of technology learned through curricular activities. Extra-curricular activities take place in the students' free time independently of demands from the HEI, and might include the following main areas, which were all referred to by the informants in our interviews:

1. Projects: Students may create and/or manage their own projects, for instance managing a smart house
2. Make own things: Students may program various devices to fit their own needs. For instance, students buy Raspberry Pi's or create their own webpages.
3. Staying updated: Students who are interested in the field also tend to stay updated when it comes to new technologies, developments and trends in the market. This typically involves active participation on social media like LinkedIn and Twitter.
4. Summer jobs: Students get experiences from summer jobs, or they do have a part time job while they study. It seems that graduates that wants to learn more, use their knowledge or explore work-opportunities have these jobs.

These extra-curricular activities make the student apply the knowledge and skills acquired through activities in the HEI, and validating employability with respect to personal attributes, achievements, skills and understanding.

We also note that the recruitment managers ask for a number of characteristics that they do not explicitly link to extra-curricular (or curricular) activity. This includes organizational understanding, oral and written communication, having a good CV/diploma, showing teamwork abilities, being a lifelong learner, a problem solver and having technical skills e.g. with scripting, cloud services, virtualization and specific tools like Azure and Linux.

V. Discussion

As the result showed, it is important to both look at the curricular and extra-curricular activities to understand how employability can be gained and validated. The discussion will look into what the higher education institution can do to support these activities. It will also provide some implications on how curricular and extra-curricular activities can increase employability together.

The popularity of the IT network administration study program in the labor market can be taken to indicate that the graduates from this specialization have high employability. According to a survey about employment (the 'Candidate survey') regularly conducted by the HEI, the IT network administration graduates get jobs easily and quickly. As explained by the informants in the study– the employers are satisfied with graduates they have hired from this specialization, and therefore continue to hire candidates from the study program

Taken from these indicators, it might be a good idea to look more closely into what the HEI provides to the graduates: what employability development opportunities are provided, and what aspects of employability are affected.

As shown in Figure 1 and argued e.g. in [9], HEI provides the graduate with opportunities to develop their employability, but employability also develops outside of the curricular activities. We argue that in the case of the study program in IT network administration addressed in this paper, the HEI provides employability development opportunities *both* in curricular and extra-curricular activities, by creating a space for the latter and good synergies between the curricular and the extra-curricular.

A. HEI support for curricular activities

In terms of curricular activities, the HEI provides support in the following main areas: teaching activities, collaboration with others, assignments and bachelor thesis.

Teaching activities: At the IT Network Administration study program there are intro lectures to the technologies, after which the students are told to work without the teacher to get hands-on experiences with the technology. The teaching activities are made to engage students, e.g. introducing them to LEGO-robotics, or drones, or while lecturing about security; get presented for password protectors for PC and mobile which the students often adopt themselves. Frequent updates to the curriculum is necessary in order to keep up with rapidly changing technology. This is emphasized to the students, and they are encouraged to examine several platforms and solutions to be prepared for future transformations. By giving them access to highly flexible and available platforms for observing and exploring changes in technology the HEI aims to foster an interest in staying updated within the field, which is an important aspect for the recruitment managers.

As for today, the IT Network Administration study program does not include a practice period. Other disciplines (like healthcare education) include practice out in the field, for the students to get familiar with the way of work, to apply their knowledge into practice, and to get organizational understanding. This might be a possible direction for the IT-educations as well. Having a practice period might give the students more interest in the field, more motivation to work hard with their assignments, and increase the employability of the students even more.

Collaboration with others: The HEI provides the graduate with several courses which involve teamwork. The students formulate and sign a contract which makes them accountable to the others in the team. How the team is going to work together to reach the goal or deadline is defined by the team itself. The teamwork fosters increased focus on social skills, and includes negotiation and problem-solving. Furthermore, it demands that the team has structure, and teaches them how they should work together to reach the deadlines and goals necessary to pass the course. On several occasions the teamwork ends in presentations for the whole class, and in this way trains the graduates in speaking to a larger audience.

Assignments: Graduates at the HEI get introduced to new technologies and tools. Typically, students are presented with one way to achieve the desired outcomes during the curricular activities, but are provided with resources to find their own way during the assignments. During this process the academic staff take the role of a collaborator rather than instructor, and try to

give hints in order to help students achieve the desired learning outcomes through their own effort. This way of working pushes the teams to find the answer to their questions themselves, preparing them for work life, when help might not always be available.

Bachelor thesis: In this case the students get to work with organizations when they write their bachelor thesis. Here the student is located at the company and work with them. This creates a more realistic setting for the students, and helps them develop an organizational understanding. Getting experience in a realistic work environment is an easy way to increase the employability for the student.

B. HEI support for extra-curricular activites

In terms of extra-curricular activities, the HEI provides support in the following main areas: identity area, access to technology and work in student organizations.

Identity area: Teaching activities are heavily reliant on students working on assigned tasks, and to facilitate this the students have their own allocated area, referred to as their "identity area". There each group can have their own dedicated seats to conduct co-located work on school assignments. In the identity-area there is also interaction between second and third year students, where they exchange experiences from both curricular and extra-curricular activities. The area is not assigned to students according to a schedule, but can be used freely throughout the day for any such activities. As a consequence, this area is also an arena for discussing personal side-projects related to the field. It is possible that the "identity area" can make the graduates feel part of a community, and might help them to get an understanding of how a professional community works.

Access to technology: A central element of IT-education is to provide resources where graduates can gain and expand their technological skills. This is, in large part, done with agreements that allow students to use resources such as cloud platforms and software. On campus the majority of the lab-exercises are based around a virtualization platform designed as a "private cloud" where students in this study program typically have access comparable to "Infrastructure as a Service", but there are also other service models and other platforms from external providers. As previously mentioned, students in their second year are working in groups that are responsible for their own physical server, and have the freedom to configure this in the way they consider best suited to solve the assigned tasks. As illustrated by Figure 2, students have an easy access to the server room from their identity area. With each group having their own isolated domain there are few constraints on when they are able to tinker with this platform, and both problem-solving and fine-tuning outside of curricular activities are both possible and encouraged. This is further enhanced by introducing the students to various operating systems and software tools, both freeware and solutions available through the HEI from partnerships and agreements.

Student organizations: On campus there is an active student organization that has a group of dedicated IT-operators providing several services to their members as well as other local non-IT student organizations. Several members of this group have come from IT Network Administration study program, and this provides the students with a great opportunity to apply skills and methods from the curricular activities. This also gives insight in organizational understanding and enhanced skills such as teamwork and oral communication. The student organization has chosen to be visible in the identity area, providing free coffee for students there. Their members are frequently present in the area and often take an interest in ongoing activities providing insight and sharing their experiences.

C. Contributions

In this discussion we have elaborated on how the HEI supports curricular and extra-curricular activity likely to strengthen employability, with reference to the model in Figure 3. The model points to the connection between curricular and extra-curricular activity, and we have argued about how they are connected in practice in the study program of our case. The teaching staff at the university believed that collaboration with external businesses and a focus on student active learning methods was the reason for the high employment rate, but according to the findings there are also other reasons why their students are so popular. For instance, the HEI provides the students with identity areas and technology (such as dedicated servers) available for experimenting also outside school hours, and encouraging participation in student organizations, which both is believed to foster interest in the field.

Through a strong focus on student-active and practical approaches to learning, the students get work related knowledge. As previously stated, graduates from IT Network Administration study program get job easily, and only a few candidates opt for further academic progression. The graduate (see Figure 3) is highly attractive for employment, have good practical knowledge, and eager to start working and earn money.

We see two main contributions from this work.

Firstly, we have presented insights about how a higher education institution can support curricular as well as extra-curricular activities, helping students improve their employability through both types of activities. The case explored in our study is a bachelor program with a technical and rather practical orientation, which means the relevance of the approaches might be highest for study programs sharing these characteristics.

Secondly, we have built on existing research and our empirical findings to conceptualize a model highlighting the role of interest in the field as a characteristic impacting on employability. The model was used as a conceptual tool framing our discussion, and may be developed through further research.

VI. Conclusion and Further Work

The focus of this paper was the employability of graduates and how a higher education institution can provide support for the development of employability. We referred to the existing research literature to argue about the importance of considering both curricular and extra-curricular activities as sources of employability. Our study explored employers' perspective on employability through interviews with recruitment managers in organizations that employ graduates from a particular IT network administration study program. The graduates of this program are perceived as generally having a high degree of

employability, taken from the ease with which they get a job after graduating.

Our interviews showed what particular characteristics are sought after among employers, our findings largely corroborating those of other studies on employability but pointing in particular to the significance of students' interest in the field. The employers in our study assumed that a high interest in the field leads students to engage in extra-curricular activities which require the use of, and thus can be seen to validate, knowledge and skills which the HEI aims to develop through curricular activity.

ACKNOWLEDGMENT

We would like to thank Kristin Hagen for her transcriptions and help with the analysis and coding.

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Paper 2

Perceived Employability in Online Education

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NOKOBIT 2019

Errata:

Page 2, the reference (Vanhercke et. al. 2014) should be corrected to (Berntson & Marklund 2007) in the text:

"PE can be gauged by having the individual rate themselves with respect to a set of statements (Vanhercke et al., 2014) reflecting five different aspects of PE (see table 1)."

PERCEIVED EMPLOYABILITY IN ONLINE IT EDUCATION

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Abstract. *In this paper, we use an online bachelor study program in IT as a case for research on Perceived Employability (PE). Collecting data from alumni through interviews and a survey we find an increase in students' PE during their bachelor education. We also find a difference between students who had relevant work experience before their studies and those without such experience, the former having higher PE before their education. This gap decreases and is not significant after completion of the bachelor program, except for the aspect of Contact Network. We discuss the results in light of how PE can be used as a construct in the evaluation and development of the specific bachelor program of our study and other study programs. We suggest that PE can be used to measure some important aspects of a study program, but as part of an overall evaluation, it should be combined with questions about competence and satisfaction.*

Keywords: Perceived Employability, Online education, Undergraduate

1 INTRODUCTION

An important aspect of online education is that students often are more diverse than traditional campus students. Online students are typically older, study with different progression, and often maintain other responsibilities such as employment, family, or financial commitments (Ely, 1997). Over half of online students in Australia work full-time while studying, and 26% work part-time (Anderson & Zawacki-Richter, 2014). Due to this diversity, a study program might have a problem facilitating the education to be relevant for all student groups and making students employable. In this paper, we use an online study program in Norway as a case to look more into this problem.

Employability is a term used to define what a student should possess in terms of "achievements, skills, understandings and personal attributes, that make graduates more likely to gain employment and be successful in their chosen occupations, which benefits themselves, the workforce, the community and the economy"(Yorke, 2006). The term employability can, as this definition shows, be used on three different levels (Thijssen, Van der Heijden, & Rocco, 2008): The macro-level considers employability from the perspective of the whole society/country (e.g. McQuaid & Lindsay (2005)). The meso-level comprises the employer perspective (e.g., as measured by the work readiness scale (Caballero & Walker, 2010)) and the higher education perspective (e.g., by Generic Skills Assessment (Hambur, Rowe, & Le, 2002)). Finally, the individual level considers employability as viewed by the graduate (e.g. Fugate, Kinicki & Ashforth (2004)).

According to Vanhercke, DeCuyper, Peeters & De Witte (2014), there are three approaches to employability. The first approach is to mainly consider competence, where an individual needs to have the competencies that are sought-after in the employment market. The second approach is dispositions which are about how proactive an individual is towards employers or a career (Vanhercke et al., 2014). Whereas both competence and dispositions influence a person's chances on the job market, research has found that it is more important for employability to focus on, and increase job-related skills and knowledge, than it is to stress dispositions, e.g., by improving job search strategies. Specifically, this is the case when job-related skills and knowledge are weak (Wittekind, Raeder, & Grote, 2009). The third approach to employability is perceived employability (PE) which concerns the subjective consideration of employability, and the possibilities for employment an individual have (Berntson & Marklund, 2007; Vanhercke et al., 2014).

PE is important for applying for and maintaining a job. PE affects an employee's perception of their job performance, a high degree of PE making it more likely that an employee believes they perform well. Also, a high degree of PE is associated with lower levels of job exhaustion and psychological issues. In general, PE is important for employees' well-being (Berntson & Marklund, 2007; Kinnunen, Mäkikangas, Mauno, Siponen, & Nätti, 2011).

PE can be gauged by having the individual rate themselves with respect to a set of statements (Vanhercke et al., 2014) reflecting five different aspects of PE (see table 1).

Table 1. *The five aspects of Perceived Employability (PE)*

1. My competence is sought-after in the labor market
2. I have a contact network that I can use to get a new (equivalent or better) job
3. I know of other organizations/companies where I could get work
4. My personal qualities make it easy for me to get a new (equivalent or better) job in a different company/organization
5. My experience is in demand in the labor market.

A concept related to PE is self-efficacy: A person's belief in their ability to succeed (Bandura, 1994). Self-efficacy has an impact on a person's ability to cope with challenges in work-life (Stajkovic & Luthans, 1998) and can be measured by the use of questionnaires. Berntson, Näswall & Sverke (2008) conducted an empirical study to find the relationship between self-efficacy and employability. They measured the latter by using the five statements proposed by (Vanhercke et al., 2014) for gauging PE, along with a sixth statement: "I could without problems get an equivalent job in another company/organization". The study showed that employability and self-efficacy are distinct but related concepts and that employability predicts self-efficacy, leading to the conclusion that strengthening employability may lead to stronger self-efficacy. Another reason to apply PE as a theoretical construct, as well as a basis for the empirical investigation, is that compared to a view of employability that considers competence or dispositions, PE has a stronger focus on contextual factors (Vanhercke et al., 2014). In the case of graduates in online education, for instance, PE is a perspective that can help us capture how the students, many of whom have extensive work experience, see themselves with respect to a job market with which many are already familiar.

A study program can influence PE by supporting students' attainment of learning objectives and by providing opportunities for acquiring knowledge and skills beyond these objectives, as intended in Constructive Alignment (Biggs & Tang, 2011). Universities should, therefore, provide students "*with a combination of academic knowledge, personality, and behavioral development and the development of soft skills*" (Matsouka & Mihail, 2016).

Learning relevant to PE can also happen outside of the higher educational institution (HEI) (James, Warhurst, Tholen, & Commander, 2013). Skills could be acquired at home, during part-time work, through extra-curricular activities or other activities at the HEI. The extra-curricular activities are often complementary to the skills learned at HEI (Clark, Marsden, Whyatt, Thompson, & Walker, 2015). While extra-curricular activities are generally positive for their job application (Lundberg, Gaustad, & Krogstie, 2018), work experience may, however, make students less confident, since they become more aware over how the employment market works and what challenges they will face (Jackson & Wilton, 2017). PE can also be influenced by factors that are hard to change. PE might, for instance, be affected by the age of the student because older students tend to have a better awareness of the labor market (Jackson & Wilton, 2017).

Figure 1 illustrates the development of a student's PE during education, starting with a Pre-edu PE at the outset and ending with a Post-edu PE after completing the education. PE might increase over time, leading to a positive ΔPE_Edu. Some of the changes might be due to the studies (ΔPE_study) and some to other activities (ΔPE_other). An underlying assumption here is that a study program should lead to a better ability to judge one's employability. Ideally, we would expect both ΔPE_study and ΔPE_other to be positive. It is challenging to measure the two latter and understand how they interact, but by measuring ΔPE_Edu and considering other data about students' perception of the study program and factors of possible relevance to the students' learning and employability, it is possible to get some indication of what impacts on a possible observed (perceived) overall change in PE.

On this background, our first research question is: "*Does perceived employability for online IT students increase during the course of a study program?*". We apply this question to a case comprised of online students in a bachelor program in IT.

Furthermore, it would be reasonable to think that the students who already have professional experience, have higher PE than students without this experience. Thus, our second research question is: "*Do online IT students with relevant job experience before education have higher perceived employability than students without such experience?*"

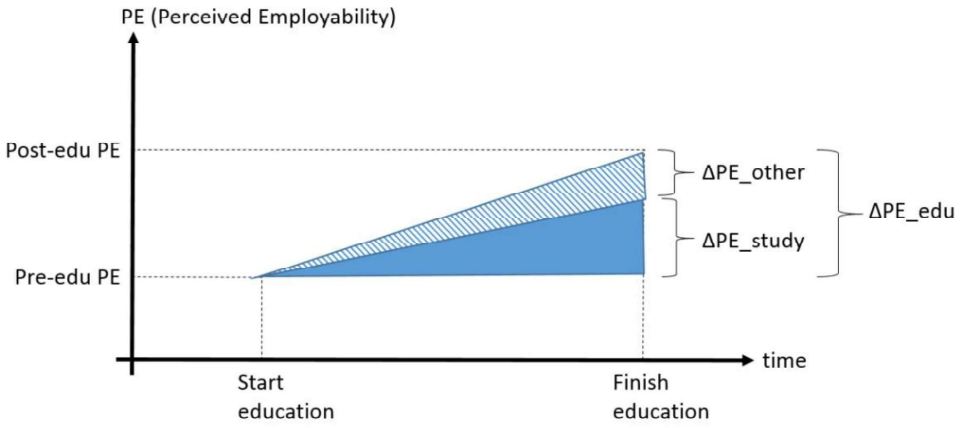

Fig. 1. *Expected change in perceived employability during the course of a study program in higher education*

2 CASE

The case addressed in this paper is the bachelor program Information Technology with specialization in Information Management (ITIM), which gives a broad basis for specializing in organizing, distributing, and maintaining a company's electronic information. The program is built up of smaller courses and is designed to be flexible and adapted to the needs of students who may have full-time jobs and need to take the study program part-time with a progression that fits them. Even though there are 45 study places for admission each year, only 15-20 graduates after three (or more) years.

ITIM is fully online and distributed, with no physical meetings, which means that students can study when they have time. Most of the courses are lesson-based, so the students read a lesson and do associated exercises. Video lectures and webinars are offered in some courses. Several courses are built around project assignments where students must collaborate through different collaboration solutions. This allows the students to gain competence in special areas, and at the same time, get trained in effective distributed interaction and collaboration. Almost all the ITIM students do their bachelor thesis in collaboration with industry, solving real problems.

The traditional way of going through the educational system in Norway is to complete high school before attending higher education. Students who start at ITIM have an alternative entry into higher education. ITIM students can be categorized into three different backgrounds (See fig 2); 1) Straight from high school or with an additional year of military service or folk high school; 2) Having been in employment for some years. These students often do not have any education beyond high school; 3) Having started after attending other higher education where they either a) felt the way of teaching did not fit them, or that they did not like what they learned, or b) wanted an additional degree to make themselves more sought-after in the job market or wanted to take a study program that matches their interest in technology.

When they start at ITIM, many of the students continue in their job. Some attend ITIM with 100% progression in addition to their 100% job, while others have half workload in their job and/or half progression at ITIM. Some students that had a job before entering the program quit their job to take the education with 150% progression.

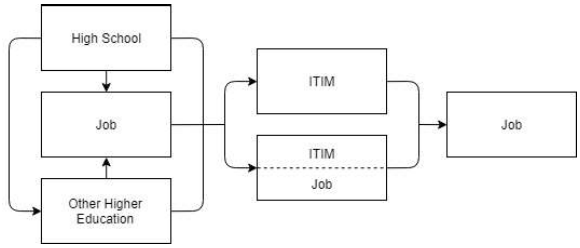

Fig. 2. *Alternative entranceways to ITIM, different progression during the study, and at the end: a job*

The Norwegian Agency for Quality Assurance in Education (NOKUT) conducts an annual survey to measure the quality of all study programs in Norway. In this survey, ITIM gets a moderately high score on employment relevance, slightly lower than the average of all IT studies in Norway. Scale: 1=a small extent; 5=a large extent:

Table 2. *Employment relevance in the ITIM program compared to the mean of all IT programs in Norway*

The study program…	ITIM	Avg.
…is relevant for the employment market	4.1	4.4
…gives good employment possibilities	3.9	4.4
…gives competencies that are important in the employment market	4.1	4.2
…has good collaboration with the employment market	2.6	3.7

3 METHOD

For our research study, we used a mixed-methods approach, collecting data from the alumni by the use of semi-structured interviews combined with a questionnaire survey.

For the interviews, a total of 28 e-mails were sent out to alumni that graduated in 2017 or 2016. This resulted in seven semi-structured interviews; four alumni from 2017 and three alumni from 2016. The interview was held face-to-face, over Skype, or by telephone. An assistant transcribed the interviews. The assistant and the main author collaborated on the coding and analysis of the transcripts.

The results from the interviews were diverse and included interesting viewpoints on the ITIM study program. Some informants were very negative, while others positive about their learning outcome and employability from the study program. These findings were, however, insufficient for substantiating any conclusions about employability among the ITIM alumni. The analysis of the interview data helped us identify several questions that could be further explored by administering a survey.

For the survey-round, we contacted all alumni who had completed their education between 2010 and 2018. This gave a population of 93 possible recipients of the survey. Since the e-mail list consisted of email-addresses students had when entering education, it was hard to get responses, and some email-addresses were not in use anymore. After one initial email with a link to the survey, and another follow-up email, a total of 45 alumni (half of the population) did respond in one way or another: 29 alumni completed the whole survey, 7 answered most of the survey, and 9 alumni did not complete much of or did not want to participate in, the survey.

The main topic for both the survey and the interviews was employability, and what the alumni think they have learned from the bachelor program. The survey consisted of 27 questions where the majority of these questions were on a five-point Likert scale from “Strongly disagree” to “Strongly agree”. There were also some open-ended questions and “Yes/No” questions.

To capture Pre-edu PE, Post-edu PE, and ΔPE_study (see figure 1), we used survey items addressing the five aspects of PE (Berntson & Marklund, 2007) separately. Previous literature (Vanhercke et al., 2014) does not provide sufficient ground for us to combine the measurement of these five aspects into

a single measure of PE. By considering the PE constituents separately, we can explore possible differences among them. We ran chi-square tests, independent samples t-tests of mean difference, and paired samples t-tests of mean difference on the survey results.

One of the authors is the study program leader for ITIM and has broad knowledge about the program as well as a stakeholder interest in its quality and improvement.

4 RESULTS

In this chapter, we will present the results from the survey and the interviews.

The respondents and interviewees are alumni from the study program in question, but we use the term *students* for simplicity when we present and discuss the results. Most of the participants (71,4%) in the survey ended their study program during the last three years.

The results from the survey show that 86 % were employed before entering ITIM, 6 % was unemployed, and 8 % were students in higher education. We also asked if they had worked in IT before. To this question (N=29) 55 % reported having worked within IT previously, while 45 % had not.

4.1 Perceived employability

In our survey, the alumni were asked to answer questions about their PE before entering their education, and after they graduated. We expected to find a difference in PE before and after the education, i.e., a positive ΔPE_Edu (see Figure 1).

First, we tested the distribution of answers through the Chi-Square test, where we tested each PE aspect (see table 1) Pre-edu with the equivalent aspect Post-edu. All the five aspects of PE were significantly different Pre-edu compared to Post-edu: A. Competence x^2 (12, N = 32) = 21.6, p = 0.04, B. Contact network x^2 (16, N = 31) = 42.9, p < 0.01, C. Other organizations x^2 (16, N = 31) = 40.7, p <0.01, D. Personal qualification x^2 (16, N = 32) = 50.0, p < 0.01, and E. Experience x^2 (12, N = 32) = 25.3, p = 0.01. We see that all the five aspects of PE have P < 0,05, which indicates that the students are coherent with each other. To find out which side the students' answers lean towards, a paired samples t-test was conducted (see table 3)

Table 3. *A paired samples T-test between the five aspects of PE Pre-edu, and Post-edu*

	M_Pre (SD)	**M_Post (SD)**	**M_Diff**	**T**	**df**	**p**
Competence	2.5 (1.4)	3.6 (0.7)	-1.1	-4.6	31	<0.01
Contact network	2.1 (1.4)	2.4 (1.2)	-0.3	-1.6	30	0,10
Other organizations	2.2 (1.4)	2.8 (1.2)	-0.6	-4.8	30	<0,01
Personal qualifications	2.5 (1.2)	3.1 (1.2)	-0.6	-3.1	31	<0,01
Experience	2.3 (1.4)	3.3 (0.8)	-1.0	-5.1	31	<0,01

We see that there is a significant change between the competence students had Pre-edu and what they reported having Post-edu. We see that Competence and Experience have increased the most, with 1 or more. On the other hand, we see that Contact Network only barely increases, with only 0.3.

4.2 Previous IT-job and PE

One of our early assumptions was that students who had previous job experience within IT (Group 1) would have a higher level of PE before entering the study program compared to students who did not have previous IT job experience (Group 2). The result shows that there is a significant difference between the two groups in three of five aspects Pre-edu and in four of five aspects Post-edu.

Table 4. *Chi-square test of difference in PE between group 1 and 2 (with and without IT-job experience Pre-edu) prior education, for each aspect of PE, Pre-edu, and Post-edu, where N is the number of responses.*

	Group 1 and 2 compared							
	Pre-edu				**Post-edu**			
	x^2	**df**	**N**	**p**	**x^2**	**df**	**N**	**p**
Competence	13.5	8	33	0.1	6.7	6	32	0.35
Contact network	23.6	8	32	<0.01	20.5	8	32	<0.01
Other organizations	16.2	8	32	0.04	15.9	8	32	0.04
Personal qualifications	13.8	8	33	0.09	28.1	8	32	<0.01
Experience	25.7	8	33	<0.01	16.6	6	32	0.01

Table 5 shows the Pre-edu difference in PE aspects between groups 1 and 2. Group 1, the students with previous work experience, has a higher average on all five PE aspects. The biggest difference is found for Experiences (Gr1 = 3.2, Gr2 = 1.2), while Personal Qualifications has the lowest difference (Gr1 = 2.9, Gr2 = 2.1) (see table 5).

Table 5. *Independent samples t-test of differences in PE between group 1 and 2 (with and without IT-job experience Pre-edu) before starting the bachelor program*

Pre-edu	**Gr1_mean (SD)**	**Gr2_mean (SD)**	**T**	**df**	**p**
Competence	3.2 (0.9)	1.7 (1.5)	3.4	27	<0.01
Contact network	3.0 (1.1)	1.3 (1.2)	3.9	26	<0.01
Other organizations	2.9 (0.9)	1.5 (1.5)	3.2	26	<0.01
Personal qualifications	2.9 (1.2)	2.1 (1.0)	2.1	27	0.05
Experience	3.2 (1.1)	1.2 (1.1)	4.8	27	<0.01

Post-edu the situation is different. There are no significant differences between student groups in four out of five aspects. Contact network is the only aspect with significant differences (Gr1 = 3.3, Gr2 = 1.7, $p<0.01$) (see table 6).

Table 6. *Independent samples t-test of differences in PE between group 1 and 2 (with and without IT-job experience Pre-edu) after completed bachelor program*

Post-edu	**Gr1_mean (SD)**	**Gr2_mean (SD)**	**T**	**df**	**p**
Competence	3.7 (0.8)	3.5 (0.7)	0.5	27	0.59
Contact network	3.3 (1.0)	1.7 (1.1)	3.8	27	<0.01
Other organizations	3.4 (1.0)	2.5 (1.2)	2.0	27	0.05
Personal qualifications	3.5 (1.1)	2.8 (1.1)	1.6	27	0.13
Experience	3.6 (1.0)	3.0 (0.6)	1.9	27	0.06

4.3 Attractive in the labor market

In addition to questions about PE, we asked some supplementary questions related to employability in the survey to validate the result. We asked a yes/no question about whether the education had made students more attractive on the employment market or not. All participants answered "yes". On the follow-up questions on why they have become more attractive, the three most frequently given reasons were 1. that they now had a diploma that showed their skills (nine answers), 2. that they had increased their competencies (eight answers) and 3 that they had got a job (four answers) (N=29). The interview data does confirm this. On a question regarding whether or not ITIM had made them more attractive in the employment market, one participant stated: "*yes, [the study] worked perfectly to get me a job – I went directly to a job [after I graduated]*". One other interesting aspect from the interview data is that several of the participants stated that they learned a little bit of everything. One participant stated: "*I do doubt that ITIM makes me more attractive [in the employment market]. [... Because] you have very*

many courses during these years, without gaining any good deep knowledge in any of the courses. And I think the employment market primarily sought-after deep knowledge." Several of the informants in the interview suggested that the study program might not offer enough deep knowledge and that the study program was easy, perhaps even too easy.

An additional employability question was asked in the survey, where the alumni had five options. The question was "would you employ/hire a student from this bachelor program?", where most of the alumni gave a positive answer: (N=29) eleven alumni would definitely hire someone, eight alumni would hire someone if they had the right electives, five alumni were unsure if they would hire someone, while four alumni would not hire someone without any other experience, and one alumnus would not hire at all.

To summarize the result section, we have two main findings:

1. The students in the online IT bachelor program have a lower PE when entering education (Pre-edu) than when they graduate (Post-edu).
2. The students who have had an IT job before entering the study program have higher levels of PE Pre-edu than those without such job experience. Post-edu, this difference has decreased except for the Contact Network aspect.

5 DISCUSSION

Our first research question was, "*Does perceived employability for online IT students increase during the course of a study program*"? An underlying assumption was that our students gain job-relevant skills and knowledge by completing the study program (and possibly engaging in other relevant activity in parallel) and that this should lead to some increase in their PE, given the connection between PE and competence (Berntson & Marklund, 2007; Jackson & Wilton, 2017; Vanhercke et al., 2014).

The answer to the first research question is yes – for all five aspects of PE, there is a significant difference showing an increase in PE. Going back to figure 1, we see that ΔPE_edu is positive (see fig 1) (See table 3 for results).

One could argue that the positive change in ΔPE_edu is not an unexpected result. There are, however, similar studies with different findings: In the study by Jackson and Wilton (Jackson & Wilton, 2017), students in higher years of a business undergraduate program had lower PE than students in their first year. Jackson and Wilton argue that the difference may be the result of students becoming more aware of the challenges they will face as professionals and their increased understanding of the employment market. In our case, we have many students who already have experience as employees, often in (IT-) relevant types of work, when they enter the bachelor program. This might imply starting with a good understanding and awareness of the employment market and a relatively realistic perception of one's employability. One could, therefore, argue that students do not get affected by the phenomenon discussed by Jackson and Wilton (Jackson & Wilton, 2017) because they already have a good knowledge and understanding about the industry before their education.

Even though all five aspects of students' PE generally increase throughout the ITIM study program, we found that the increase in the Contact Network aspect is very small. This suggests that while the students have some degree of contact network at the beginning of the program, ITIM does not provide enough opportunities for extending the network. Collaboration with industry throughout the program is already in place through some course assignments and the bachelor thesis: The thesis should preferably be and typically is initiated by an industry partner (e.g., the student's employer), addressing real-life problems rather than purely theoretical issues. However, we would like to see a marked perceived improvement in the students' contact networks. An implication for the development of the study program is that collaboration with industry throughout the program should be even closer, which might be achieved by looking into and improving the existing collaboration activities and/or introducing new ones.

Considering the relative influence of ΔPE_study and ΔPE_other (see fig. 1) on the overall increase in PE, the data from our study provide no accurate measures. We can, however, reasonably assume that both play a role, in a way linked to the characteristics of the study program. Regarding ΔPE_study, ITIM provides students with several courses where there are practical tasks that need to be solved to increase

students' practical skills in combination with theory. Through obtaining these skills and getting knowledge about the employment market through industry realistic assignments, with the bachelor thesis as a good example, students can see the relevance between their study program and the employment market, and that the skills obtained will lead to increased self-efficacy, employability, and then again increase ΔPE_study.

Another explanation for the result could be that the study program is too easy – so that students do not experience resistance, leading to an unrealistic level of PE. According to the interview-data, this might be an issue: students perceive the study program as too easy. The informants were concerned about learning too little and wanted the study program to provide more opportunities to learn more in-depth. From the survey, we see that Competence and Experience have increased the most, which can indicate that the ITIM study program does provide students with good opportunities for developing competence and experience. This is also shown in the survey from NOKUT (described in the case-section) where students agree that competencies learned during the study are important for the employment market.

Regarding ΔPE_other, one likely source of improved PE is the work experience gained by the part- and full-time employed students in parallel with their bachelor studies. We see that students with relevant IT job experience before education, have higher Perceived Employability Pre-edu compared to the students without such experiences, but that this difference decreases during their education. Post-edu there are no significant differences between the two groups in four of the aspects of PE. One of the reasons may be that students without relevant job experience before the education are able to get relevant part-time job experience during the study program, and therefore increase their ΔPE_other (see fig. 1).

Post-edu there is only one PE-aspect that distinguishes students with or without relevant job experience, Contact Network. It seems that students with previous job experience had a contact network Pre-edu and that this contact network still is there. Neither students with nor without IT-job Pre-edu does seem to have increased their contact network much during the education. As previously argued, the study program needs to provide opportunities for students to get to know each other, as well as the industry better so that they could increase their contact network if they aspire.

The answer to the second research question "*Do online IT students with relevant job experience before the education have higher perceived employability than students without such experience?*" is that there is a difference in PE between the two groups before the education, but Post-edu there is only one aspect that separates the two groups.

The measurement of PE by having students rate the five different aspects of PE finds support in the research literature (Berntson & Marklund, 2007; Jackson & Wilton, 2017), which was the basis for our use of such survey items in the research reported in the paper. Our study shows that there is coherence between the use of PE measurement tool used and whether informants feel employable for the industry. We know from the research literature that PE is related to the individual's well-being and mental health (Berntson & Marklund, 2007), which means that including items on PE in a student survey might provide information about such issues.

We have used PE to research how alumni students experienced their perceived employability retrospectively – both before entering their education and after completion of their bachelor program. This is a limitation to the study. Over 70 % of the survey participants graduated during the last three years, and one could expect that they know what is needed in the industry after started working there. The retrospective view on PE could, therefore, give answers that are more in agreement with how industry is working compared to measuring PE when students start the study program, without being aware of what is expected in the industry. The findings of our study substantiate that it is reasonable for the specific study program of our case to make some changes: fewer courses will give the students a deeper specialization in areas currently high in demand in the industry and give the study program a uniform profile. This is likely to contribute to students' perception of developing relevant and sought-after competence.

The results from our study further suggest that PE could be actively used as a parameter in study program development more generally, to help measure the effect of the changes in profile, specialization, and depth. PE as a measurement tool can be used by various stakeholders. An obvious possibility is to use it to ensure that the students acquire relevant knowledge and skills in education and experience these as

relevant in the industry. This can again be linked to the development of the study program in order to be able to uncover the student's experience of lack of knowledge or skills. Addressing employability by considering PE along with other perspectives, including a competence-based perspective, may be necessary to compensate for an acknowledged weakness of PE: the lack of information about *why* individuals see themselves as having a particular level of employability (Vanhercke et al., 2014). As pointed out in our research, the development of PE happens both through the study program (i.e., the learning activities) and on other arenas (such as hobby projects or a job), which should also be taken into account.

6 LIMITATIONS AND FURTHER RESEARCH

Having students assess their PE (both Pre- and Post-edu) retrospectively introduces a validity threat that can be avoided by measuring PE in the same student cohort at several points in time, i.e., in a longitudinal study. Further research should measure PE early in the first year and repeated, e.g., close to graduation and a couple of years after. This would lead to a more precise picture of students' initial PE and its development over the course of completing the study program. Furthermore, insight about first-year students' PE and its different aspects can be used as input to faculty and others directly involved in supporting students' learning from day one.

7 CONCLUSION

The research presented in this paper used Perceived Employability (PE) as a measurement tool for identifying whether students think that an online IT bachelor program provides them with the right competencies, skills, and understanding so that they become employable within the IT-industry. We found that PE does increase during the education, and in this case, it is most presumably a combination between what is learned from the study program itself and what is learned through relevant job experience gained in parallel with the studies.

The findings in this study may be transferable to other IT study programs. The study program in this paper has many similar courses with study programs held at campus, though taught in different ways. Therefore, there are grounds for claiming that there are transfer values in relation to the acquired knowledge at this study program are similar to other study programs. In this research several students had work experiences prior their education, which also are the case for some campus students. This imply that we as a higher education institute need to not only help establish a contact network for online students, but also for campus students.

Considering the evaluation and development of study programs more generally, our results show that exploring students' perceived employability can enrich our understanding of how students perceive a program. We recommend measuring PE already early on in the first year of a study program.

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Paper 3

From Employable to Fully Operational: The Need for Training of ComputerScience Graduates

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From Employable to Fully Operational: The Need for Training of Computer Science Graduates

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Abstract—For graduates in computer science and informatics to get employment as IT professionals, there is a need for their education to provide the competence sought after by employers. To become fully operational in the organization, the candidates typically also need to further develop their competence there, engaging in activities, and becoming familiar with the practices in the company. For a university offering master's degrees in computer science and informatics, it is important to know the employers' view of the relevance of the study programs and what is possibly considered to be lacking. Also, it is essential to know whether the missing part needed to become fully operational should be provided by the university. In this paper, we investigate these questions by asking employers of master students in IT. As a significant new contribution, we use the framework of modes of identification by Wenger-Trayner and Wenger-Trayner to find out if the graduates are aligned with the discipline, engaged in activities, and able to imagine their future in an IT-position. A combination of in-depth interviews and a survey is used. Analysis of the findings shows that employers overall find the candidates' competence from the university to be adequate. We argue that collaboration between university and industry is essential to this success, pointing to a set of key steps in the process from entering a study program to becoming fully operational in work life.

Keywords—Employability, Training, Higher Education, Computer Science, Graduates

1 Introduction

This article is based on an article published in EDUCON 2020 [1], which has been revised and extended. The significant new contribution includes a theoretical analysis based on the *modes of identification* framework by Wenger-Trayner and Wenger-Trayner [2]. Computer Science (CS) and Informatics is two different master programs at focus in this paper, where a master within CS contains more mathematics.

Being a new employee in an organization entails becoming a member of a community of practice [3], gradually developing expertise, and becoming more proficient in the organization's work practice. This is a learning process that can happen through formal and informal training. Workplace learning is always partially informal [4] and

takes place as the employee is working and learning from experience and collaborating with colleagues. Additionally, formal in-house training can be provided. An employer recruiting new candidates from higher education (HE) expects to have candidates with an adequate starting point for this learning period, both the time to become "fully operational" and the continued and indeed life-long learning that follows.

Considering computer science and information technology graduates, the candidates usually get hired quickly after graduation. At the same time, companies spend substantial resources on training the candidates to become fully operational. For the HE institutions, it is of great importance to know whether the candidates have the right competence upon graduating and whether the following months and years in work-life make them the IT professionals needed by employers and society. Interesting questions to explore include: What does it mean to become fully operational? What are graduates trained in, and how long does it take to become fully operational within a company? Does the graduate lack any competence which should have been taught in HE?

Employability may be understood as the skills, knowledge, and personal attributes needed to get a job [5]. This is the possession perspective on employability [6]. In this article, however, we will look at employability from a process perspective, where identity formation is at focus [6]. In this perspective, employability could be seen as pre-professional identity formation, which "*relates to an understanding of and connection with the skills, qualities, conduct, culture and ideology of a student's intended profession"* [7]. Further, we see employability from the meso level, which is the industry and HE perspective [8]. Competence is in this article understood as the *"ability to use knowledge, skills and personal, social and/ or methodological abilities, in work or study situations and in professional and personal development"* [9]. When we talk about students/graduates "getting a job," we refer to relevant, normally full-time employment in commercial businesses or public sector, starting after completion of the university degree. Finally, for simplicity, we use the term "industry" to refer to employers in commercial businesses, public sector as well as NGOs.

Modes of identification, as defined by Wenger-Trayner and Wenger-Trayner [2] (previously *modes of belonging* [3]) is a way to describe how someone forms their identity through their participation in a landscape of communities. Modes of identification consist of three aspects: First, *Imagination* – where the ability to connect the past and the present will help students imagine their future, and could serve as a guideline for students' choices or exploration of new possibilities. Second, *Engagement* – where involvement in communities with different sets of competence gives students experience as they engage in practices, talk or debate, and use or produce artifacts. Third, *Alignment* – where students align to the discipline by coordinating their perspectives, actions and interpretations. In this article we will use modes of belonging as a perspective to find out how employers view students' identity formation in a hiring process.

In Norway, there is a relatively low unemployment rate in general (3,9% was unemployed in 2018) [10]. Within the IT-field, we have a high and increasing demand for software programmers and application developers, as well as system architects and analysts, while other IT graduates seem to have some challenges getting a job, as

reported in [11]. According to this report, there seems to be a mismatch between employer needs and the qualifications of the unemployed graduates. Accordingly, coordination between the employers and the HE sector is needed to make sure that the graduates get the qualifications sought after by employers [11]. A study of Norwegian bachelor students in a college in southern Norway found that 26% of the IT students get a relevant job without applying at all. Including students who sent between one and ten applications before they got a job, the employment rate is 78% of all IT bachelor graduates [12]. An internal report from the biggest university in Norway pointed that 95% of their master graduates had secured a job before delivering their master thesis. This shows that both bachelor and master level IT graduates in Norway are in demand in the labor market.

Online presence in social network sites is seen as important for career management and professional identity development by graduates [13]. In hiring situations, employers value the candidate's participation in online communities related to the candidate's field, e.g., GitHub or StackOverflow [14]. Visible achievements in such communities can give employers an impression of the graduate's coding skills. Hobby activities, such as having one's own programming projects, and staying updated in the field, are essential, providing an opportunity to demonstrate that the graduate can apply the knowledge gained in HE [15] and be aligned with the discipline. Also, engaging in extra-curricular activities like organizing events for student societies or other organizations might increase the chances of getting a job and contributes to learning new skills outside of the university [16]. This can broaden students' experience, which makes them able to imagine their future through other people's narratives and experiences [17].

Academic achievements are, of course, a key factor in the hiring process. In Norway, larger companies hiring IT professionals tend to focus on academic qualifications first, using grades as a selection criteria for interviews before looking into personal qualities [18]. Smaller IT companies, tend to start with personal attributes, to find out whether the person fits the company socially, before looking at the academic achievements [18].

Being aligned with the discipline is a key step to develop a pre-professional identity, where gaining skills, knowledge and having personal attributes relevant for the discipline is at focus. The candidates' communication skills (primarily written) are reported by employers as frequently too weak [19] or lacking[20]. Also, emotive communication should be emphasized in engineering education [21]. In addition to the communication skills, newly hired graduates also seem to lack collaboration skills, technical skills, cognitive skills, and orientation skills [22], or lack the ability to use these skills [23]. It is not the lack of "experience in programming, design or debugging" that causes problems for newly hired graduates, but the social conditions at the new workplace [22]. When a graduate is searching for employment, skills in areas like project experience and problem-solving often determine whether the graduate gets a job or not [24]. These non-technical skills are often underestimated by graduates [25].

Companies generally expect to take responsibility for teaching newly hired graduates' specific requirements for their job, because it is almost impossible to define what

requirements the professional areas have towards graduates in any generic sense, even when focusing on only one requirement like writing [26]. Even within a company, there may be little agreement about what competence is most important [27].

Collaboration between the industry and the university makes them understand each other and could contribute to teaching graduates valuable skills through guest lectures and real-world insights to the students [28]. Some skills can also be hard to achieve through courses in a university setting (e.g., working with clients or work-life experiences) [24], and the educators should, therefore, consider telling the students what skills they do *not* learn at university so that they can find other areas to learn these skills [29].

A significant body of research argues that we need to educate students to become employable. From a process perspective on employability, this means helping the students become fully aligned with the discipline, engage in activities to gain competence, and imagine a future within the discipline. In the field of computer science in the Nordic countries, recent years have seen a shortage of people and a high demand for graduates with Computer Science degrees. This was the case in the autumn of 2019. More recently, the COVID situation has had an impact on the work market in Norway [30]. Given the current pandemic, it is interesting to investigate the effort needed in the organizations to make the graduates fully operational. To this end, in this paper we attempt to provide answers to a set of questions:

- Do employers hire graduates who lack knowledge needed in the company, and use resources to train them to get the needed competence, or are we educating students who already upon graduation fulfill the requirements from the industry?
- How do employers view students' employability from the perspective of modes of identification, where student's alignment, engagement, and imagination in the discipline and for an IT job are essential? How do employers influence student's pre-professional identity during their education period?

We differentiate between the discipline-, company-, and HE communities, where students become more competent in the discipline throughout their education and continue to develop their competence during their training and their employment. A student could be seen as not very competent in the HE community, but through engagement in hobbies and having own interest, he/she be counted as competent in the discipline. Also, each IT company forms their own community, and such communities have different ideas related to competency.

To investigate this, we have looked into employers' perspective on employability and the need for extra training for students from two specific study programs. In the next section, a description of the case is provided. We next present our research method before the results of the study are provided. An analysis is presented in the discussion section. The paper ends with a conclusion and an overview of related work.

2 Case

For a more detailed case description, see [1]. The master study programs investigated in this study include one in computer science (MCS, 5 years integrated master) and one in Informatics (a 3+2-year program).

In the MCS program, the first two years consist of fundamental courses in computer science, mathematics, statistics and some courses in physics, philosophy, and science theory. In the third and fourth year, the students specialize in four main areas: Software, Databases and Search, Artificial Intelligence, and Algorithms and Computers.

This structuring into specializations reflects the traditional way of organizing the Computer Science field covering the Computer Engineering (CE), Computer Science (CS), Software Engineering (SE), and Information Systems (IS) areas of ACM Curricula [31], while also meeting the continuously developing needs of industry and society.

The Informatics master program offers students who already hold a Bachelor of Computer Science (except CE) similar possibilities to specialize in their fourth year, with some mandatory and some elective courses within each of four specializations.

For MCS and Master of Informatics students alike, the fifth year includes the Master thesis, which is often undertaken in collaboration with an external client from industry or public sector. While the MCS is more structured than the Informatics program, the programs in practice show significant overlap and are generally considered by employers as equal with regard to the candidates' level of competence. Both master programs have very high admission requirements, the MCS generally being regarded as the most attractive master program in computer science nationally. There are approximately 140 MCS students and 100 Master of Informatics students each year at this university.

Collaboration with industry happens in different ways, e.g., by having external stakeholders take client roles in student projects (e.g., in the context of research projects), be course examiners, take part in study program development, and visit as guest lecturers. These activities ensure that the study programs keep up to date with the industry's needs and simultaneously let industry benefit from the competence and recruitment potential inherent to these activities. To support close collaboration with relevant partners, the faculty has organized a formal network of key industry partners that can be involved in an advisory role when there is a need to gauge the needs and concerns of industry, e.g., when study programs are evaluated and changed. The industry network also arranges events offering industry contact, especially for students in their early years. The companies in the industry network hire regularly from the study programs at focus.

An important part of the picture when considering employment and employability of the candidates from the study programs addressed here is that the work market in fall 2019 was very favorable for the candidates. The students often get their first regular job early in their last year. In reality, the recruitment process starts earlier, as the industry (e.g., consultancy companies) frequently employ students for summer jobs after their fourth year, using the internship as an occasion to evaluate the candidates

before possibly offering regular employment. A survey-based study showed that 87% of the master students had a relevant summer job by the time they finish their 4th year, and 64% of the master students report that they had such a job already in their 3rd year [32].

3 Method

In this chapter we will briefly describe the method used in this research. For a more detailed description, see [1].

The study presented in this paper used an exploratory research design [33] .The sampling approach included defining the sample universe and sample size, deciding on a sampling strategy, and recruiting the participants [34]. Our sample universe and inclusion criteria for the interviews were that the informant should: (1) have hired students from master's programs mentioned above, (2) be located in the same country as the master's programs, (3) work closely with students from the master's programs, (4) be a part of the industry network presented above. For the survey, the inclusion criteria were that the company should: (1) have hired students from master's programs mentioned above, (2) be answered by a leader for IT employees or someone else involved in hiring new IT employees.

The sampling strategy for the interviews and survey was convenience sampling. The survey combined this with purposive (quota) sampling to cover two strata (private and public sector).

A total of 16 e-mails were sent out to ask for an interview. We received 11 answers, and six respondents were willing to participate. Two of these respondents were from the same company but represented different roles and organization units, and they were both included in the sample as it was considered likely that they would provide different perspectives. The informants were managers or department leaders.

The interview questions targeted a) background and how familiar informants were with master's program, b) skills, knowledge and personal attributes a graduate have/should have/lack, and c) graduates' need for training and their expectations about work life.

The survey questions covered a) background and the informant's familiarity with the master's programs in question, b) education (competence gained through the study program) and training (competence gained after being employed in the organization), and c) employability (which positions newly hired graduates get, what are their strengths, other possible candidates for the position). The survey was tested out with several faculty members and iteratively improved. The answers were anonymous.

The survey was sent to all members of the above-mentioned industry network and additionally sent to a number of companies that have previously been hiring from the study programs. 50 invitations for the survey were sent out, resulting in ten respondents.

We have done a thematic inductive analysis, where we followed Braun and Clarke's six phases of thematic analysis [35]. First, we familiarized ourselves with the data before we identified and applied initial codes. Then we searched for themes and

did a re-coding to make sure we got all relevant data coded. We defined the theme to be education and training, where graduates becoming fully operational was the main goal for employers. The analysis was data-driven, where the research questions were developed from the codes [35].

4 Results

We will here present the main results from the interviews and the survey and will clarify the source under each point.

Most students from the master programs in this case seem to get the same type of entry position when they start working, according to the data in the interviews and survey. Programmer, system developer, or software developer are the relevant positions mentioned. Other positions graduates are recruited for is researcher, data scientist, or android/web developer. There seems to be a common understanding that the employees remain in these positions only for a few years, before proceeding to another role. Informant 1 explains: *"They have been recruited as a software engineer. Everyone starts in this position. [...] and then, after some years, it could be 3-6 years, things start to happen. You get promoted to an architect or team leader, project leader, or something like that".*

4.1 Skills, knowledge and personal attributes

Several of the informants mentioned that they do not expect a graduate to have in-depth knowledge, but a broader knowledge base, which the graduate can build on during their training. According to the informants, this knowledge base should contain two or more programming languages, math, algorithms and data structures, knowledge of security issues, and how to deal with them, UX, database, cloud development and knowledge on how to manage version control. Some informants also point out that graduates should know different paradigms for software development and understand different frameworks (Informant 1, 3, 4).

Other skills considered necessary by the informants are problem-solving skills, teamwork skills, communication skills (in different languages, and the ability to describe a technical problem to a nontechnical person), understanding of being part of a bigger system, and the ability to think holistically. Also, lifelong learning seems vital in the view of all informants, based on the argument that graduates should be able to acquire new knowledge fast as technology changes rapidly. Graduates should be able to quickly adapt and adjust to technological development.

A graduate's interest in the field is mentioned as a very important factor for hiring. Graduates should *"convey their interest in the field, an interest in developing themselves in the field in which they have taken their education"* (Informant 1). Further, it seems that the easiest way of deciding whether a graduate has this interest or not is by looking at the projects or hobbies in which they have been engaging. Otherwise, the graduate has to convince employers during the interview that they have the interest and the motivation needed.

When asked about which skills and knowledge the graduates usually lack, most of the informant's answer *"nothing specific."* Two of the informants say they are happy with the knowledge and skills the graduates possess, but that the graduates use some time to learn agile development properly. In the survey, the lacking knowledge and skill areas mentioned the most were teamwork (cross-disciplinary and/or global teams), communication (with non-technical persons or persons from other fields) and agile development. There are no trends in the answers related to the size of the companies.

4.2 Importance of grades

How much emphasis a company puts on grades seems to differ; Some are more focused on getting graduates with experience and argue that *"you could be a graduate with extremely bad grades which turns out to know a lot, but that the study situation is not entirely suitable for this person. Some of our best people have little or no education. [...] the reason [for this is] that we sought after graduates with extreme interests in programming and development, and we think that this [interest] is expressed through experiences"* (Informant 5). Others are mentioning motivation and internal drive for the field as important factors when hiring graduates (Informant 1, 2). Some are more focused on the grades, arguing that a graduate should have a high-grade average, but that they allow some low grades - but that the graduate needs to be able to defend or explain why they have them (Informants 1, 4).

Some of the informants argue that which courses a graduate has is important, and that they need high grades in the courses relevant for the company (Informants 4, 6). One of the informants seems to disagree on the importance of personal attributes, arguing that it is an advantage to have a hobby outside of the education, but that they *"do not hire people based on their personality"* (Informant 6).

4.3 Students' expectations

Companies do not agree whether students have realistic expectations towards the employment. One company mentions that students do not know what types of work (work tasks) are associated with the typical roles in the work market. In a hiring situation, students get asked where they want to be after 3-5 years in the company and most of them answer system architect, however, few are able to explain what an architect does, according to informant 1.

Another informant wants students to be more visionary: *"we need people to understand that the work they do could revolutionize the world. That is the motivation they should have when graduating. Believe that it is possible because it is!"* (informant 2).

Some informants argue that students have realistic expectations towards employment, especially at the end of their education (informant 6), even though they might not have worked 8-hour days when they studied (informant 5).

4.4 What do the graduates learn in their company training?

The companies report a variation of what graduates need training in to become operational in their company. Some inform that the graduates learn *"a lot about the company, our strategy, visions. However, they also do some project work, which is closer to software development"* (Informant 1). Others mention teamwork and use the time to define the new employees' role, responsibility, and contribution (Informants 2, 4) and tools to use for version control, testing and quality assurance (Informant 4). Also, the quality of the product (Informant 2), and how to deal with large, complex systems with a large user group, and significant risks (Informant 4) are a part of the training in one of the companies in the study. One company runs a bootcamp in embedded programming to make sure that all new employees are on the same level (Informant 6).

In the survey, we see that smaller companies do not have a training program, but that the training happens while the new employees work, under close supervision by the nearest leader. The middle or bigger companies have an onboarding program taken by all new employees. Here graduates learn about the company - their rules, values, culture, and history. Some companies offer additional courses for the graduate to attend depending on which competence they lack and where they will start working. One company has answered that the graduates they hire usually do not need any additional competences to become fully operational, and that their training only includes "getting to know the company"-topics.

There are different opinions on how long it takes to make a student fully operational, ranging from six months to two years. Most of the informants think the time usage for training is as expected, while two of them think it is too long. One informant report that graduates mainly need to learn about the company during that time. In the survey we see that companies with fewer employees report a shorter training time for new employees. Also, some of the interviews address the time it takes to get fully operational: *"... the new employees join a program that takes 3-4 years. Internal training, training, much traveling, you learn about the company, how we work."* (Informant 1). Another informant argues that each employee needs a different amount of time to get fully operational.

To frame our results with respect to the modes of identification perspective, we consider the development of modes of identification as an ongoing process throughout education and training. In Figure 1, we provide a schematic view of the process a student/employee goes through. When starting at HE, students have some competence from high school, which is often reflected in their grades. The admission criteria at HE filter out the best candidates and offer them a study place. Students' competence increases during their education, and by the time students graduate, they are employable graduates and have developed a pre-professional identity. This stage lasts until the graduate gets hired, which is often right before graduation, or directly after, depending on which study program they graduate from. After being hired, the new employee takes part in some form of training program, formal or informal, which increases their competence enough for them to become fully operational employees.

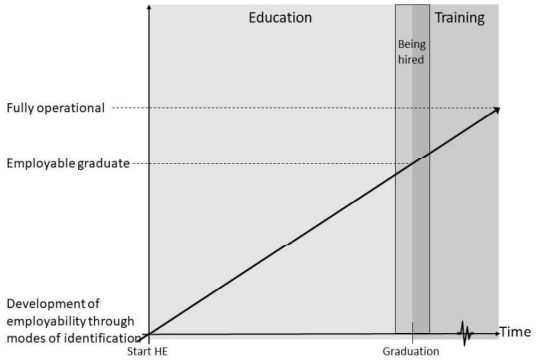

Fig. 1. Developing employability through modes of identification from the beginning of higher education until fully operational in a company

Although not shown in Figure 1, as described in the description of the case, recruitment can be seen as starting before graduation, especially through the summer jobs offered by the companies. Although this recruitment mainly applies to students between their 4th and 5th study year, students are also employed for summer jobs earlier on with recruitment in mind. Informant 1 explains: *"We have had people from first-year computer science here. They have been here for 2 or 3 summers in a row. [...] I have tried to go in very early [to recruit students], between first and fourth year"*. The informant further states that summer jobs are perceived as a long interview for a position in their company.

5 Discussion

In our discussion of the results, we use the perspective of modes of identification to look at the employment setting as an acceptance of a student's pre-professional identity. Further, we look into which specific competence graduates need to become aligned with the discipline and obtain a pre-professional identity sought after by employers. Finally, we consider the process from education to becoming fully operational.

5.1 Graduates' engagement, alignment and imagination

The results indicate that many employers focus on the skills and knowledge students should have to become employed. Through modes of identification, we see that this could be understood as how experienced and how aligned the graduates are with the discipline. The informants mentioned frequently candidates' interest in the field as important, which is consistent with previous research (e.g., [15]). Projects related to

volunteer and hobby activities demonstrate that the candidates have the skills as well as the drive and dedication sought after by many employers.

When students demonstrate that they have an interest in the field, they provide evidence for engaging in activities that give meaning for the community. By broadening their experience through participation in hobby activities, the students become able to imagine other opportunities, or perhaps more realistic opportunities, because they can explore their possibilities through other people's narratives. As described in the background section, students should look outside the university for acquiring skills not provided by the university [16].

As students get to know companies from early on in their education, they become able to imagine many of their job possibilities, and what they want to work with. By making sure that students are aware of their possibilities from early on, students can make informed decisions about which electives they should choose. Some students might also invest in hobbies or extra-curricular activities that make them able to pursue the job of their dreams. Some employers state that new employees must learn about what their responsibility are, what their role entails and what contribution they are expected to make, to ensure that they understand the cultural code in a company. That students are not able to imagine what people in different roles, e.g., an architect, do, but still think they will be able to fill those roles in 3-5 years, can indicate that they need more insight about their job possibilities.

One of the informants mentioned that they would like the graduates to become more visionary and imagine the possibility they have to make an impact in the world through developing revolutionary programs. However, students cannot imagine contributing to the world through revolutionary programs if they have no related experience, nor have gained any experiences through other people's narratives. To make students able to imagine these visionary contributions, someone need to tell them that it is possible, and give them narratives they can see themselves in. This is where industry collaboration through guest lectures and company presentations are important.

5.2 Graduates' lack of alignment, engagement and imagination

Previous research shows that the IT industry considers several skills important when hiring new employees. This includes problem-solving skills [24], communication [19], [22], and teamwork skills. Our findings are consistent with these studies. Answering about knowledge and skills found to lack among the graduates, several respondents mentioned agile development. This is a topic currently covered in the study programs, but there seems to be a gap between graduates' knowledge and what the industry expects from them. It seems that this has been an issue for several years, since several companies run bootcamps to secure that every new employee are familiar with the practices in the company. These bootcamps are also used for making sure that newly hired graduates have the same level of knowledge within e.g., the programming language used in the company. Bootcamps or training at the workplace could be seen as a way for employers to make students aligned with the company, knowing their practices in their community, and becoming engaged in activities that gives sense and meaning for the community.

Along the same vein, several informants mentioned that additional knowledge and skills in teamwork and the ability to work in cross-disciplinary and/or global teams are needed to be fully operational in and aligned with their organization. Seeing these areas in connection, there is a potential for the university to address all of them through suitably designed student projects in agile development. Such projects can deliberately incorporate challenges and learning objectives related to cross-disciplinary [36] and/or global [37] teamwork, preferably with an external client to provide authenticity. On the other hand - all of this is already covered in existing project courses, which indicates that the university is already providing the right type of learning but might consider improving it and/or providing more of it. Students should be aware of the practices in the discipline, and students do learn them at university, however, it might seem as they do not learn them well enough.

Two informants from the survey report communication skills missing in the graduates. They specifically refer to communication with non-technical persons and cross-disciplinary communication, which could indicate that graduates' skills in communication with technical persons within the same field might already be at an appropriate level. Since only two companies report communication skills as lacking, it could imply that all other companies are pleased with the level of communication skills graduates have. Alternatively, as Moore and Morton argue, skills in written communication are often so company-specific that the companies expect to train the graduates in it when hired [26]. This shows that even though a student might be good in the skills seen as important by the discipline community, there is still a need for company communities to indoctrinate newly hired graduates to their form of competence.

It is a key finding in our study that most of the informants and participants answered "nothing specific" when asked about what skills are lacking in the graduates. This might indicate that the graduates that get hired generally do possess the skills needed in the IT discipline. It might also indicate that the companies are aware of some shortage of specific skills but accept this and include it in their training period. The findings should, in any case, be considered in light of the current high demand for computer science graduates: there is a chance that employers would respond differently had the work market been different.

Grades are, from the point of view of the HE institution, intended to reflect the candidate's level of skills as described in the learning outcomes of the courses and study programs. The disagreement between the employers on the importance of grades, may indicate that they are diverse in their thoughts on how modes of identification are achieved. Some employers might find evidence of engagement and alignment through grades or having "the right" electives, and others find this through interests, attitudes motivation or cultural understanding. It is known from the general recruitment practices of large consultancies that grades serve as a key mechanism for filtering out candidates for personal interviews [18]. The quote "We do not hire people based on their personality" (Informant 6). from one of our informants may be illustrative of this approach. The technical interviews and case assignments increasingly used by employers as part of their recruitment process serve to assess the candidates in essential ways with no connection to (although possibly a correlation with) grades.

In seeing different views on desirable skills in new candidates and the significance of grades in employing them, we should also take into account that different skills are needed for different roles in different types of organizations, e.g., technical experts, scientists, and customer-oriented consultants. These differences mean there may be different reasons to consider grades in general and grades in specific types of courses in particular. Also, in the current work market, there is strong competition to get the best candidates, which means it can be harder for smaller companies with fewer resources for marketing and recruiting, e.g., startups, to compete for the best candidates. Having less visibility and perhaps less appeal to larger groups of students means there may be fewer candidates to select from, which makes getting the right person with the right motivation and practical/technical skills more important, e.g., as demonstrated through a technical interview.

5.3 The process from education to becoming fully operational

An employment processes can be understood as a learning process from a graduate point of view, where employers check if students are sufficiently aligned, engaged and able to imagine so that they can work in the company. One can say that the employers define if you have shown a pre-professional identity that is of their interest, or if the student are not professional enough in their point of view.

As explained in the Case section, there is a significant collaboration between the university and industry to ensure the relevance of the study programs in question. We believe the close collaboration between industry and university, including the student associations, to be essential in explaining the overall satisfaction with students' skills seen among the employers in our study; students are aligned, engaged and have the possibility to imagine their future.

Based on 1) the number of employed students, 2) that the industry think that the time used for training is as expected, and 3) that several of the companies think the graduates have the expected competencies needed to get a job, one could call the process from education to fully operational graduates a success, as graduates are being aligned with the discipline, engaged in activities that give meaning to the community, and able to imagine themselves in a future job. We see five interconnected and related key steps in the process of becoming fully operational: 1) Admission to the HE programs, 2) Introduction to the industry through HE, 3) Summer jobs, 4) The recruiting process, and 5) Training in the industry. In what follows, we will elaborate on these steps.

Admission requirements for the HE program: Due to the popularity of the study program, the admission requirements are high, making it hard to enter. This is affecting which students enroll in the study program, and how dedicated and engaged they are in their learning. Highly competent students, when they arrive at a study program, give highly competent students graduating from the study program [38]. The admission requirements thus affect the competence of the graduates, making them more competent compared to study programs with lower admission requirements.

Introduction to the industry through HE (guest lecturers, events): Close collaboration with the industry leads to guest lectures and events for students held by the

industry like career days, presentations of the industry with additional dinner and drinks, courses held by the industry for the students, and speed interviews for summer jobs. The collaboration makes students able to imagine which jobs they are able to get, and what it entails to work in these jobs. Students get to know the companies before they apply for a job at them and get a closer understanding of which company that matches the students' interests and values, and how students can work to become more aligned towards their dream job.

Summer jobs: Several of the companies have opportunities for the students to get a summer job, which makes the student get to know the companies well, and the companies have an opportunity to get to know the students well. The summer jobs give the students experience in their field, as well as they will develop an understanding of how work life will be. Students are able to get to know cultural codes, and practices which make them aligned toward the company and the discipline. Through extending their experience, students become more able to imagine their future, and connect their past and present, making choices in the present that will help them in the future. A summer job could also provide students with additional skills not provided by HE [39]. On the other hand, students who did not get a summer job might be negatively affected: both in terms of not having the experience to put on their CV, but also their self-esteem might be affected.

The recruiting processes: The recruitment process starts already from the first time the industry meets the students. Through courses and guest lectures held for the students, companies might seek out talented students and make them motivated to apply for a job after graduation early on. Several informants state that they see summer jobs as a long interview for a position in their company. This could make the student hopeful that he/she will get a job, and perhaps mentally "lock" themselves to one firm already from the first year. Recruiting students early or hiring students before graduation might affect their motivation in positive (I have got a job, I would not disappoint them) or negative (I got a job, I can relax and not worry about the grades) direction. This needs further research. If the student has not been recruited through summer jobs, several of the companies report that they have interview rounds with case and technical tests.

Training in the industry: After getting a job, students get a period of training within the company. Some have intensive courses everyone must attend, while others have a more learning-through doing method as described further above. This will make students become aligned with the company – knowing their practices, culture and norms.

The process as described here reflects the situation before the COVID-19 pandemic, and the current situation have affected the number of unemployed students with a master degree [30]. There is reason to believe that events arranged by the industry for students and the possibility to get summer jobs have became fewer in 2020, but the effect of this will first be apparent in 2021 and later. This could affect students' ability to align with companies and gain experiences that makes them able to imagine their future. Also, engaging in hobby activities together with others, and participate in training after being hired have become harder. Unless the training and the hobbies take place online, students and newly hired graduates might have problems attending

it. This could, in the long term, make students less aligned with the discipline, unable to engage in activities seen as important by the discipline and company community. Without hearing narratives from companies and becoming able to use the experiences of others to imagine their future, students will be less prepared for employment. We as a university should make sure that we avoid this, and continue to hold close collaboration with the industry, to make sure that students get to know them and their work.

6 Conclusion and Future Work

The study presented in this paper shows that even though there is a high demand for IT graduates, companies do not hire candidates who lack the right competencies. Employers report that they are pleased with the competencies graduates possess when hired, which could be a result of a recruitment process that is complex, long-term, and based on close collaboration between the university and industry. We have shown that the recruitment process is complex, starting from the students' first year at the university, and that it involves a process of engagement, alignment and imagination on part of the students This use of modes of identification framework represents a novel contribution to employability research.

We see that even though students might be aligned with the discipline community and that they get good grades in their courses, they still need to take onboarding programs and have a training period. We see this as a process as becoming aligned with the company community. As several informants have mentioned, newly hired graduates need to get to know the company culture, practices, and norms. This alignment to the company cannot happen in the HE institution because they cannot prepare students for all the different companies. The focus on grades and hobby activities could indicate how well the graduate are engaged and aligned with the discipline, which could help employers to understand how much more training is needed to become aligned with the company as well. If a graduate is not well aligned with the discipline, it would be harder for the company to make the graduate aligned for the company, since many of the discipline specific practices also are used by companies in their everyday life.

Collaboration with the university gives the industry a better understanding of what training they need to provide to close the gap between the competence to be expected from a candidate at graduation and the one needed for being fully operational in work life. The collaboration between employers in the IT industry and the institutions educating IT candidates thus results in a clarification of expectations regarding employability.

A limitation to the study is the relatively small sample. The sample is large enough to show the variety in the recruitment process of CS and Informatics master graduates in Norway, however, having a larger sample might have shown which training processes companies tendence to use or a bigger variety in the training processes. Future work, including a larger sample and possibly an international sample, could show the differences in training between larger and smaller companies, pure IT companies and

companies in other domains who are extensive users of IT, or Norwegian and international companies.

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Paper 4

Students' Imagination of Future Employment – Identity as an Important Employability Aspect

Gunhild Lundberg, Ingunn Johanne Ness

CSERC 2020

Paper 5

Employability Through Imagination, Alignment, and Engagement - Students' Prospects and Change During Their First Year in Computing Education

Gunhild Lundberg, Birgit R. Krogstie

Koli Calling 2020

Employability Through Imagination, Alignment, and Engagement - Students' Prospects and Change During Their First Year in Computing Education

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ABSTRACT

Employability can be defined as a part of one's identity formation, or pre-professional identity formation. In this paper, we have interviewed six computing students at the beginning of their first semester and in the middle of their second semester, exploring their perspectives on being a student and future professional. The results show that students have started their identity and employability development by aligning themselves with the practices in the computing discipline, engaging in a study program community, and imagine their future professional identity. The article gives recommendations on how Wenger-Trayner & Wenger-Trayner's concept of modes of identification can be used to enhance employability in first-year computing education.

CCS CONCEPTS

• **Social and professional topics → Computing education programs**.

KEYWORDS

Employability, Identity, Undergraduate, Modes of identification

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1 INTRODUCTION

In computing education, research on employability includes studies on which skills a game developer needs [5], which skills are most important for computer programmers to become employed [8], the skill gap between the graduate and the industry expectations [15], and managers' preferences when hiring software engineers [10]. The latter study found that employers should avoid candidates who are not aligned, not well mannered, or not asking for help. Students need to be aware of the industry needs [11] and what they will learn during their study program. However, it is essential that students become aware of what they will not learn through their studies, so that they know the potential knowledge gaps in their education and can choose to seek other arenas to cover this gap [10].

In the IT sector in Norway, the work market is currently favorable for new graduates. A national survey in 2018 showed that there is a lack of IT-workers: the demand was twice as high as the registered unemployment. The demand has increased remarkably over the last few years while unemployment has gone down [16].

Several studies have found that employers highly value personal qualities [12] and non-technical skills, of which teamwork and cultural fit are most important [8]. Students who demonstrate an interest within the computing discipline thereby prove for employers that they are able to use their knowledge in practice and engage in continuous self-development, which validates their employability [12]. The university has a responsibility not only to teach skills and knowledge but also to be an arena for personal and behavioral development and development of soft skills already from students' first year at university [13]. The university should also be clearer of what role computer science can play in society, as many students are attracted by this aspect of CS [7]. Students with this interest might *"struggle to fit into this general student discourse"* [7] since students often think of being a programmer as the only way of being *"competitive in pursuing a degree in computer science"* [1]. The major reason for students to drop out is that they lack the feeling of belonging in computer science and have lost interest in the field or in the possible career choices [2].

Employability has been reconceptualized to be Pre-Professional Identity (PPI), which relates to *"an understanding of and connection with the skills, qualities, conduct, culture and ideology of a student's intended profession"* [6, p 2]. From this perspective, employability is not only about having the right skills and knowledge, but also about being aware of what profession one is wishing for, "how we do it" in this profession, and what counts as competence in this profession. Formation of PPI during students' education is enhanced by imagination, reflection, visualization, and reconciliation, which helps students in *"demonstrating preparedness for employment and successfully applying their acquired skills and knowledge in the graduate labour market as a novice professional"* [6, p 18]. To have a social identity and an idea of oneself is essential for transitioning into the job market [14].

To be able to develop a PPI or career identity, students should be aware of their career possibilities. This should be informed and promoted by higher education (HE) to the students [1], from early in their study program [11]. In this way the students can use other

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people's narratives to imagine what they have not seen and broaden their experience [18]. Early career awareness and knowledge about career options can affirm the educational choice [4]. If the students want to contribute in the society or aim to make a difference, they might have a hard time feeling that they belong to the discipline [7]. However, project courses within computer science have been proved to foster identity development and develop students' feeling of belonging to the discipline [17].

The theory of Community of Practice (CoP) by Lave and Wenger [9] was further developed by Wenger [19], who introduced "modes of belonging", later renamed as *modes of identification* [20], in the identity component. We use modes of identification as our framework for looking into identity formation in HE. There are three modes of identification, which is explained in the following way [20]:

- Engagement "is the most immediate relation to a landscape of practice – engaging in practice, doing things, working on issues, talking, using and producing artifacts, debating, and reflecting together. [...] engagement gives us direct experience of regimes of competence, whether our engagement is a visit or a lifetime commitment..." [20, p 20].
- Imagination: "We use images to locate and orient ourselves, to see ourselves from a different perspective, to reflect on our situation, and to explore new possibilities". [...] "These images are essential to our interpretation of our participation in a landscape" [20, p 21].
- Alignment: "our engagement in practice is rarely effective without some degree of alignment with the context – making sure that activities are coordinated, that laws are followed or that intentions are implemented." [...] "...it is a two-way process of coordinating enterprises, perspectives, interpretations, and contexts so that action has the effects we expect" [20, p 21].

In this paper, we explore whether modes of identification can be used as a framework to explore students PPI development and get a picture of their employability development. Our research question is: How can modes of identification be used to explore students' employability process? By answering this question, we can find out if modes of identification provide an appropriate theoretical framework for this purpose and if it can be used by universities to shed light on important aspects of education to facilitate employability and identity development.

2 CASE

In the paper we look into a bachelor program in cybersecurity and infrastructure (DigSec), which was new in 2019. The students interviewed in our study attend the first year in the first cohort of this study program. DigSec originates from a previous study program with a slightly different focus [12]. The case description and the data collected in the study presented in this paper, relate to the situation prior to Covid-19.

The study program has a close collaboration with the industry through company presentations, guest lectures, speed interviews with students, and the use of industry contacts for grading bachelor projects or other exams. DigSec has emphasized that the students have some discipline-specific courses from the first semester to make sure that they get a sense of their chosen discipline early on. In their first semester, they have a course in programming and one in basic infrastructure. In addition, the study program puts every student in a permanent team of 3-5 students who work together on weekly assignments. After the first semester, students may change teams if they want.

The students have a so-called identity area where all their lecturing and lab exercises happen. This area is always open for students outside of the scheduled teaching. In addition, a server room is available for students to try out everything from cabling to routing, hands-on. In the lab-exercises, students are free to work on their own, but the teacher is in the room to help on request.

Teachers make students aware of the industry relevance of the study program and course by telling students stories from the industry. They also encourage students to be interested in the discipline through game-based learning activities, e.g. "Capture the flag." Teachers see these initiatives as preparing students for employment and acquiring skills sought after by employers.

3 METHOD

The study is longitudinal and based on the collection of data in the first and second semester of a study program in 2019/2020.

In the second week of the first semester the students were asked to answer a survey, where they could sign up for interviews. Eight students decided to participate. The interviews were held by the first author in October 2019, i.e. 2,5 months into the first semester.

The initial interview guide was designed to explore what the informants thought of their future employment options and choices. Many of the questions were directed at students' understanding of the education they had chosen: – what is infrastructure, and what is cybersecurity? What are the students supposed to learn in these areas, and which jobs can the students fill when they graduate? These questions were formed with a close connection to the concept of CoP and the imagination part of modes of identification. The second-round interviews were held in March 2020, 2,5 months into the second semester- Six of the eight students from the first interview round agreed to participate. We broadened the interview guide to include engagement and alignment.

For the interview transcription we hired student assistants. The first author imported the transcriptions into NVivo. In the analysis, Braun and Clarke's [3] six phases for thematic analysis were used, the researcher reading through each transcript before generating initial codes and searching for themes. The authors are employed in the department responsible for the DigSec study program but do not have any other connection to the program.

4 RESULTS

The students interviewed give the impression of being closely connected to their team and their class since they answer individual questions by referring to "us in the team". We note that the students are very clear about how to proceed with respect to help-seeking when struggling with an assignment or task, i.e., whom to ask: the team, other students, student assistants and teachers.

A potentially more problematic aspect of the class as a community is the in-group / out-group conception that some students do

not "fit" in the class or type of study program. One of the informants, despite continuing her DigSec studies, stated that she feels she does not fit in the study program. The other informants directly or indirectly convey that there are *other* students who do not fit in. Student 7 explains that *"there are many students that have applied for this study program without having any relation to IT. Everything is new. They lack the most basic IT knowledge, so the study program might be harder for them than for us who have some experience"*. The informant who believes she does not fit in, sees herself as a "misfit" with no experience or interest in computing: *"I'm a different person by nature, this is not my dream. I don't know if it's a good idea or not, but here I am"* (student 3). She continues this reflection in interview 2, asking open questions to herself: "Have I made the right choice?" and "do I want to work within IT?". Even though many of the informants mention the diversity in the class concerning "fitting in," there is agreement that the social environment is good. Students 6 and 8 argue that working in a team is motivating and a good social learning experience.

Students mention presentations held by companies as their main source of information about future jobs. An issue with these presentations is that they often are intended for students at all study programs in the department and thus not always perceived as completely relevant for the DigSec study program. Students also need more information about how a typical workday might look like in different types of jobs. Student 5 elaborates: *"When companies come and present for us, they usually explain what study program they want students from, before explaining what the company does. [...] I know what companies do and what their goal is, but I don't know how to use this education on a daily basis"*.

Seeing oneself as a professional in the future is not only about roles in work life, but also one's place, goals, and achievements in society more generally. We asked students what challenges in the society they think they will be able to solve after taking this education if they could do anything they wanted. Several informants point to cybercrime as the main challenge in society within their discipline. The students talk about how people get their computers hacked and how the majority of people lack basic knowledge about the threats out there. One student was more concerned about the amount of data that is stored about each of us, and how younger people have their whole life online: *"the new generation coming have their whole life on the internet, and I think they will be more exposed to digital attacks"* (student 5). He explains further that we need to protect the data that has already been stored so that criminals will not get hold of them.

To solve challenges and contribute to society through their knowledge, the informants want to create secure computer programs or programs that change people's attitudes toward security. Student 1 and 6 argue that making a computer program that stops cyberattacks or block threats would be a nice contribution, while student 3 and 4 are more concerned about providing knowledge to the users – especially in big companies or in the government: *"the whole nation is vulnerable if one politician doesn't have their IT-knowledge because hackers only need one door to get information"* (student 3).

When students talk about their dream job, we see that many of them answer differently in interview 2 compared to interview 1. However, we do not see a pattern in this change; rather, there are many different ways: in opinion, in perspective, with respect to interests, or in terms of the level of understanding of the discipline. Student 3 has changed perspective on her dream job, from thinking she would work in a big company locally, to instead work for the government nationally. Student 1 has changed opinion about his dream job: from being mainly interested in security and being a penetration tester to become more interested in data structures and hardware. Student 2 specified his dream job in more detail, going from working with security in a medium-sized company (Interview 1) to becoming a penetration tester being hired in a third party company testing systems for larger companies (Interview 2).

Changes seen from the interviews also include personal attitudes, interests, and habits. Especially the increased knowledge of security had made the students change their habits, e.g., concerning the use of social media. Student 2 elaborates: *"I have become more security-focused, and my personal security and privacy settings are stricter than it was. Very much stricter! I think about it a lot more on a daily basis. My attitude has changed a lot since I started"* (Student 2). Several of the students also report that their interests have become more aligned to the computing discipline. Some have started programming in their free time while others have become interested in block-chain. One student has started listening to podcasts about cases of hacking throughout history (student 5).

5 DISCUSSION

As stated in the theory chapter, we think of employability as a process of identity formation, where students are developing a PPI. We used modes of identification as a framework to analyze students' employability development process. The results from our study indicate that students have a strong sense of class-community and that they have a very good social environment where everyone can talk to everyone. At the same time, several students point out that there are people who do not fit in – because they do not have any pre-disciplinary-knowledge or lack interest in the discipline. Based on these comments, it seems that students relate to the class and the discipline as two separate entities.

5.1 Engagement

Taken from our study, class-community seems to be strong among DigSec students, who frequently refer to "we" or "us" when asked about aspects of being a student. This could indicate that the relations within the team and class are close, which is corroborated by the stated preferences for asking one's own team for help. Several of the informants talked about how motivating it is to work in teams, since they not only solve problems together and become dependent on each other's knowledge and presence, but also have developed relations and friendships.

An intrinsic part of engaging in a community is negotiation about what it means to have competence in that community. Among the DigSec students there seems to be a more or less shared, but sometimes tacit, understanding of who a good student or participant in the classroom is. Good students engage by participating in class activities, asking questions, doing the required assignments, and generally investing time in their studying. This form of engagement in itself does however not lead to an understanding of the student as highly competent in the *discipline* community. The other way

around, a student who is competent in the discipline through interest or hobbies is not necessarily a good student engaging actively in the class community.

Taken from our interviews, the study program offers learning activities actively connecting to the discipline through stakeholders (e.g. guest lecturers, teachers with industry experience) and work-relevant aspects of the learning environment (e.g. labs allowing hands-on experience with practical tasks).

Fellow students recognize a student who engages in a discipline-related activity (e.g., through a job or hobby) as competent in the discipline. The flip side of this recognition is that students who do not participate or express interest in such activity are easily seen as "misfits" by the other students, as expressed by the term "fitting in" in several of our interviews. Our findings point to a need to explore what the idea of fitting in (or not) is based on, since students who have other perspectives, e.g., a society perspective, tend to not fit in the general student discourse [7]. The idea of not fitting in could also come from the idea that students often think that programming is the most important skill to master to be able to be competitive in a computing degree [1], and students who do not have this interest do not "fit in.". Students who feel they do not belong, tend to drop out [2].

We may also ask whether the idea of fitting in to a large extent is based on how much pre-disciplinary knowledge one has before starting at the university, which means the disadvantage of the students without this knowledge should be in focus from day one in terms of promoting engagement. Furthermore, what are the consequences of feeling that one does not fit in, or having fellow students believing that you do not fit in? A deeper understanding of these issues might help us identify specific challenges and solutions, e.g., whether students seen as not fitting in, would benefit from some kind of counseling or participation in some motivating learning activity, whether the class should be encouraged to reflect, e.g., on inclusiveness and professional identity, and whether changes to the class community practice should be implemented. This is an area of further research.

5.2 Imagination

Imagination of the future makes students connect their past and present. Imagination helps the students reflect on where they are today, where they want to be after graduation, and how to get there.

The results of our study show that DigSec students are aware of many study program specific jobs they can apply for. Students need to be introduced to their career choices early on, to help them find out if they have made the right educational choice [4]. One student question whether her choice was the right one, which might indicate that students have not received enough information about their career possibilities. On the other hand, it is to be expected that not all students are equally certain about their career paths at this stage of their education, independently of the information provided.

Several of the students' state that they do not have enough information about what employees in job positions do in their normal workday. Students cannot imagine what they have not been told [18]. The university should, therefore, be more aware of this lack of knowledge and provide students with possibilities to get this information. When guest lectures and presentations address the whole department, students may get information about jobs that are not relevant for them or fail to see that their future competence might have particular value in the discipline for which the DigSec study program is meant to prepare them. This can affect students' imagination, e.g. making them think that they have job aspirations that are not realistic. To address this challenge, the university might invite IT professionals with discipline-specific job positions. These professionals should pay particular attention to explaining, maybe finding ways of showing, what a normal workday is like, i.e. what practice in the discipline might entail.

5.3 Alignment

In our study, comparing interview round 1 to interview round 2, we see that most students have started aligning with the discipline. They have changed their habits and their attitudes toward security, knowing that they need to improve their security handling to be aligned with the discipline and the new knowledge they have acquired during their first year. Our results show that the students have changed the attitudes and habits not only when at university, but also in their free time – making sure that, e.g., their presence on social media platforms is subject to strict privacy settings. This is in line with the idea of alignment as related to identity, which in this case transcends the professional discipline and applies also to participation in other communities of importance to the person.

In our study, the students were aware of challenges in society that fall within the scope of their discipline, arguing that cyberattacks are common and that people, in general, do not have enough knowledge regarding security issues and threats. The study shows that first year students may also have coordinated perspectives on challenges in society and how to solve them, in our case manifest in the shared perception that a lack of knowledge in the majority of people is the main IT security issue that needs to be solved on a societal level.

The students have negotiated a shared practice in the class-community of whom to ask when struggling with an assignment. This practice indicates that students have started adhering to the practice in the discipline, where they collaborate with their peers, asking for help from those in the same role before seeking help from more competent people in different roles. After students understand the practices in the discipline, they can start to incorporate them in their own practices and thereby align themselves to the expectations from the industry.

Becoming aware of change and alignment is an important part of being a student since students should be aware of their development and competences. To boost students' awareness of their learning and competences, we see a need to make sure the students engage in reflection processes addressing the whole role as pre-professional and not only learning outcomes for courses.

5.4 Practical implications and limitations

Through using modes of identification as a guideline for facilitating employability and identity development, we see several practical issues that need to be emphasized by the university:

- By focusing on imagination, we see a need for more reflection opportunities, encouraging a holistic perspective of the

student, including hobbies, PPI, and life, paying particular heed to the overlaps between the relevant communities. Universities should provide students with reflection possibilities that not only include one course but student's development through a whole semester or year. Also, we see that students need to be presented not only with possible job positions but to the specifics of a typical workday to be able to imagine themselves in different jobs. The university should inform companies who present themselves to also explain the typical workday for each position.

- By focusing on alignment, we see that it is important that companies present themselves to the students in a way that is relevant for the specific study program and not generic to the whole IT sector. More tailored presentations will make students more aware of what their possibilities are as well as whom they need to align themselves to.
- By focusing on engagement, we see that there is a need for universities to also include society perspectives in education to make sure that students with other perspectives do not feel misplaced. There is a need to be clear to the students that excelling in programming skills is not the only way of being competent in the discipline. To achieve this, we recommend involving stakeholders from the discipline who can serve as role models through their engagement in the respective alternative aspects of practice.

A limitation to the study is the number of informants: six students participated in both the first and the second interview. On some topics, we got varying answers among the interviewees, pointing to the potential to get richer insights on the student population by conducting a larger number of interviews. However, on most of the topics, the findings across our interviews formed a consistent picture, indicating that our results can be used to derive insights about the student population as a whole. The DigSec class consists of 36 students, of whom we talked to 16,7%.

6 CONCLUSION

In this paper, we have explored how modes of identification in CoP can be used to understand student's PPI formation and thus employability development. The results have implications for what the university in our study should be aware of in terms of providing students with support and possibilities for the engagement, imagination, and alignment involved in building their PPI.

Our study provides a unique contribution in showing that modes of identification can be used as a framework for analyzing IT students' development towards becoming a competent professional. By applying the modes of identification perspective, to a study program, a HE institution can discover areas for improvement. These may include encouraging students' holistic reflection on their life and studies, broadening the computing discourse to also include society perspectives, and introduce students to how a normal workday in the industry would look like.

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Paper 6

Understanding Employability Through an Identity Formation Perspective - Implications for Higher Computing Education

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