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That's How We Role! A Framework for Role Modeling in Computing and Engineering Education

A focus on the who, what, how, and why

VIRGINIA GRANDE



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Abstract

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Role model is a term used in everyday language and literature on education, particularly on diversity, equity, inclusion, and access, describing topics such as motivation and inspiration. However, role model, as a loosely defined concept, is understood and used in different ways. This shows the need for a shared vocabulary and structure to scaffold nuanced reflections and discussions on the who, what, how, and why of role modeling.

This thesis describes the development of a framework for role modeling in computing and engineering education. It is focused on the role model's perspective and is of particular use for educators as role models for students, although it can be used for others in this context.

Educators were interviewed and surveyed, and the analysis comprised a phenomenographic approach, thematic coding analysis, argumentation, descriptive statistics, and group comparisons.

The framework includes the dimensions of awareness and intention of role modeling. All educators are potential role models, regardless of whether we are aware of what we are role modeling and whether we intend for this to be emulated.

What can be modeled is presented as achievements and aspects. As lenses to reflect on which ones a teacher should role model, we bring virtue ethics, care ethics, and ethics of freedom.

Context and norms matter in role modeling, such as in who is a role model, as we argue for using research on identity and the history of computing. We provide examples of how and why educators role model (or not) care, emotions, and professional competencies outside norms in the disciplines.

This thesis broadens how we understand and discuss role modeling in research and practice, including what can be modeled and obstacles to it. Practical examples (including reflection prompts) of how to use the framework are included for educators and other practitioners.

Keywords: Role model, educator, teacher, identity, norms, ethics, virtue ethics, care ethics, ethics of freedom, emotions, professional competencies, computing education, engineering education, higher education

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To Elena and Diego: my role models.

List of papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.

- I **Grande, V.**, Berglund, A., & Daniels, M. (2017, November). Experiences of Teachers in Computing as Role Models: a Phenomenographic Study. In *Proceedings of the 17th Koli Calling International Conference on Computing Education Research* (pp. 133-137). <https://doi.org/10.1145/3141880.3141901>
- II **Grande, V.** (2018, October). Lost for Words! Defining the Language Around Role Models in Engineering Education. In *2018 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE. <https://doi.org/10.1109/FIE.2018.8659104> (© IEEE 2018)
- III **Grande, V.**, Peters, A. K., Daniels, M., & Tedre, M. (2018, October). “Participating Under the Influence”: How Role Models Affect the Computing Discipline, Profession, and Student Population. In *2018 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). IEEE. <https://doi.org/10.1109/FIE.2018.8658944> (© IEEE 2018)
- IV **Grande, V.**, Lennerfors, T., Peters, A. K., & von Hausswolff, K. The Virtuous, the Caring, and the Free: Ethical Theory to Understand the Ethics of the Teacher as a Role Model in Engineering Education. Accepted with revisions for publication in *the European Journal of Engineering Education (EJEE)*.
- V **Grande, V.**, Kinnunen, P., Peters, A. K., Barr, M., Cajander, Å., Daniels, M., Lewis, A. N., Sabin, M., Sánchez-Peña, M., & Thota, N. (2022, December). Role Modeling as a Computing Educator in Higher Education: a Focus on Care, Emotions and Professional Competencies. In *2022 ITiCSE Working Group Reports (ITiCSE-WGR 22), July 8-13, 2022, Dublin, Ireland*. ACM, New York, NY, USA, 27 pages. <https://doi.org/10.1145/3571785.3574122>

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Main contributions per paper

As the lead author in all five papers, I took responsibility for the work, including planning, leading work (re)distribution and writing, contact with publishers, etc.

- I I designed the study and collected the data. I analyzed it in conversation with the second author and wrote the paper with feedback from my supervisors.
- II I am the sole author of this paper.
- III I coordinated the work from the refinement of the idea with all authors to writing the paper. My main contribution to the writing was on role modeling and connecting this to the other sections in the paper, besides taking responsibility for addressing the reviewers' comments.
- IV I coordinated the work as a follow-up of an idea published with the fourth author (see Related work RVII). I wrote the sections on role modeling literature, co-wrote the introduction and discussion with one or more of the other authors, and took responsibility for addressing the reviewers' comments with input from the other authors.
- V I had the idea for the work, then refined and delimited it with the second and third authors. The three of us coordinated the work, with me leading work distribution and meetings, timelines, and group discussions for all stages of the work. We led the creation and distribution of the survey with input from all authors. I revised all data collected to ensure there was no sensitive data. I worked on the consent information for the survey with Åsa Cajander. I led one of the qualitative analysis teams and wrote in all sections of the paper. As the first author, I often went back to revise the overview of the project and was the contact with the track chairs.

Related work

Below are listed some of my contributions to other work:

Leading of interactive sessions in conferences

- RI **Grande, V.**, Alshaigy, B., Peters, A. K., & Daniels, M. (2022, October). Who is a Role Model? An Open Discussion on the Role of Role Modeling in Engineering Education. In *2022 IEEE Frontiers in Education Conference (FIE)* (pp. 1-4). IEEE.
- RII **Grande, V.**, Daniels, M., & Peters, A. K. P. (2021, November). Reflecting on your Role Modeling with a Scientific Approach. In *WEF Engineering Education Conference*.
- RIII **Grande, V.**, Daniels, M., & Peters, A. K. (2020, October). Types of Role Models for the Frontiers in Education (FIE) Community. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-2). IEEE.
- RIV Peters, A. K., Bengtsson, S., Cajander, Å., Daniels, M., **Grande, V.**, Lönngren, J., & Salminen-Karlsson, M. (2020, October). Care ethics to develop computing and engineering education for sustainability. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-4). IEEE.

Symposia and panel discussions

- RV **Grande, V.**, & Peters, A. K. (2021). Understanding how Role Models Make and Broaden Computer Science: in Symposium 'What is the Science in Science identity?' In *Proceedings of the European Science Education Research Association (ESERA)*.

Other conference papers

- RVI **Grande, V.**, Kinnunen, P., Peters, A. K., Barr, M., Cajander, Å., Daniels, M., Lewis, A. N., Sabin, M., Sánchez-Peña, M., & Thota, N. (2022, July). Making Visible and Modeling the Underrepresented: Teachers' Reflections on Their Role Modeling in Higher Education. In *Proceedings of the 27th ACM Conference on Innovation and Technology in Computer Science Education Vol. 2* (pp. 566-567).

- RVII **Grande, V.,** & Von Hausswolff, K. (2020, October). “Mature” to Doubt: Using Ethical Theories for Role Modeling in Computing Education. In *2020 IEEE Frontiers in Education Conference (FIE)* (pp. 1-9). *IEEE*.
- RVIII **Grande, V.,** Benac Earle, C., Manresa-Yee, C., Gómez-Martínez, E., Castro, L. M., Pons, P., & Corobán, R. (2020). Everybody Rock Your Equity: Experiences of Organizing a Women in Computing Event with Role Models for Diversity and Inclusion. In *Conference on e-Business, e-Services and e-Society* (pp. 5-16). Springer, Cham.
- RIX **Grande, V.,** & Daniels, M. (2020). Who Should We Invite? A Proposal of Steps for Conference Organizers to Follow to Bring Diverse Role Models to Computing Events. In *International Conference on Learning and Teaching in Computing and Engineering (LaTiCE)*.

Acronyms

ACM	Association for Computing Machinery
ASEE	American Society for Engineering Education
CER	Computing Education Research
DBER	Discipline Based Education Research
DEIA	Diversity, Equity, Inclusion, and Access
EER	Engineering Education Research
ESERA	European Science Education Research Association
IEEE	Institute of Electrical and Electronics Engineers (outdated name, nowadays only the acronym is used)
ORQ	Overarching Research Question
RQ	Research Question
SCT	Social Cognitive Theory
SIGCSE	Special Interest Group Computer Science Education
STEM	Science, Technology, Engineering, and Mathematics

Preface

Role models. People we aspire to be like, in some ways and to some extent. Individuals who we regard as competent, as examples to be followed. People that I (as a young and inexperienced new academic) thought did not include me. Until I started teaching and a student told me: “You are such a role model! It is fantastic to see one of us at the front of the classroom”. I did not know what “one of us” meant. Perhaps that we shared gender, similar age, or, to some extent, immigrant status? I could understand this, as I was also learning from them in many ways. What I did not agree with was that *I* was a role model. But this student claiming that I was one indeed challenged my understanding and made me realize that it was them (and not me) who got to decide my “role modeling status”. More accurately then, I thought *I should not* be a role model. Students should instead look up to someone more experienced and more competent. I was still learning!

The concept of role model was far from new to me, though. I had been very active in initiatives celebrating and advocating for women in computing. In a male-dominated field such as computing, it is a common practice to expose students and professionals to examples of individuals deemed successful. This is usually done through, for example, keynote addresses. You attend a conference and listen to this amazing professional who explains their outstanding career and accomplishments. The aim is to inspire you, to spark the thought in you that, if this person could do it, so can you. At least, that is the aim we had in the organizing teams I had been part of. However, when listening to these speakers, I had different reactions. Sometimes, I was indeed inspired and took notes on how I could apply parts of their lived experience to my own path; others, I admired the achievements but came to the conclusion that they were not for me because I had different goals or because the obstacles described were not related to the ones I would encounter; and other times, sadly, I was left demotivated (how was I supposed to get where that person did? It was too late and/or too hard for me!).

So who gets to be a role model, I wondered? People we give a platform to, drawing on their competence and success, may not be perceived as role models; people who do not consider themselves role models may be regarded in that manner anyway. I realized that, simply by being in positions where others can notice us, we become potential role models, whether that is the intention or not, whether we are aware of it or not. This can be enhanced by a power position, such as being in front of a classroom or addressing an audience at a scientific gathering. But all of us are in different contexts in

which we can be noticeable in different ways. Thus, who can potentially be a role model? Everyone.

As an inexperienced teacher with little pedagogical training, I did not know how to reflect on my role modeling. And thus came the idea of this thesis: creating a framework to support reflection on different kinds of role modeling. For example, what do I think I am currently role modeling for my students? Or for my colleagues? Are there any parts of me that I could make more noticeable, such as my background, professional achievements, or interests?

But would students really see me as a role model because of my research interests? During my undergraduate studies, I did not feel I belonged in computing. I was told that my interests were not “hardcore” enough and that being interested in the relationship between people and computing was “for other study programs”. When listening to Anne-Kathrin Peters in her Ph.D. defense, describing a similar situation in Swedish undergraduate education, another realization came: social norms, what is perceived as valued by the groups we belong to, is a very important factor in role modeling.

After thinking of *what* could be role modeled, I wondered then what I *should* role model. Sharing an office with Kristina von Hausswolff, eventually, the question was raised: what does being a “good” role model mean, from an ethical perspective? If people (for instance, students) will observe me and emulate my behavior, how should I behave? While we worked on addressing this question, the effort already proved useful: I was already analyzing my behavior in professional contexts, such as when writing research in a team, and what that could transmit to others with less power.

What I could transmit included emotions and care. For example, when I started teaching, I was advised to “leave your problems at the door, do not show them to students”. I saw this as a way of caring for the students, to avoid burdening them. I was also told that it is good for an educator to make mistakes in front of the students: the students see that failing is a natural part of computing. What was the balance on which emotions should be shown and which ones should not be noticeable? Who could show flaws without repercussions, and who could not? What were ways in which I could show the students that I cared about them and my colleagues?

I felt very fortunate to find a community during my Ph.D. studies where my way of being and participating in computing was welcomed and appreciated. I started more openly expressing emotions and displaying care for others and myself. I found role models that were examples of these emotions and types of care, role modeling that, in my experience, could be so absent in computing. I felt even more fortunate to then be able to study how educators around the globe showed their own emotions and care to their students, or why they thought they should not or could not.

These thoughts inspired the cover of this thesis. Three “bigger” trees, the more noticeable ones, represent the traditional understanding of role models as people with a platform, as people who others should aspire to be like. The

“smaller” trees are found in three groups, faintly separated by rocks. Each group has examples of individuals emulating some aspects from the “big” role models: leaf color, trunk shape, tree top shape. But each group also includes a characteristic not found in the “big” role models, e.g., palm tree leaves, yellow leaves. The “smaller” trees can also be role models, e.g., one develops yellow leaves, and another emulates this. And in each group, there is at least one characteristic that is not emulated, i.e., to the left, no one has a thin straight trunk, the middle group has no orange leaves, and the right group lacks the stretched tree top shape. Because what is emulated and what is seen as not worthy of emulation can very much be affected by the group(s) of which we are part.

Role modeling is complex. It requires reflection on what we transmit, what we could be transmitting, who is part of this phenomenon, who and what is valued in the social context, etc. It can get overwhelming. This thesis is, I hope, a gentle invitation to immerse ourselves in this kind of reflection and discuss it with others. I believe much good can come out of these conversations.

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1. Introduction

In order to learn something, we may not only experience it or do it ourselves; we can also observe others in their social environments and reflect on these observations. For instance, we observe someone joking around in a professional meeting and see this causing disapproval from others; we decide to avoid joking in other meetings, as we consider how we value being appreciated by this particular group and want their acceptance. We hope this avoidance will exempt us from being found at fault. Conversely, we may observe a colleague being praised for the way they explained a concept during a presentation. We then take notes on how we can do this ourselves in the future to improve our presentation competencies. Noticing these positive (praise) or negative (disapproval) consequences of behaviors helps us as observers decide whether to imitate the behavior modeled or avoid it altogether.

Observing these individuals and the examples they represent may have positive effects. They may help us learn, for instance, new competencies. They can also motivate us or inspire us, especially when we see ourselves in them, showing us that something is possible for us [89]: “You can’t be what you can’t see”¹. This is considered especially important for members of marginalized groups, people historically marginalized because of their gender, ethnicity, etc., oppressed by systems (and those in power within these) whose designs benefit others. For instance, in parts of the Western world where white men are the norm in technology-related fields there are numerous initiatives to give the spotlight to successful individuals who are Black and/or women, aiming to motivate students from these demographics to pursue or persist in their technology-related study programs and careers (see, e.g., [15, 135, 72, 147]).

Observing individuals around us can also have negative effects on us: if we see someone like us failing, we may, in turn, change our belief of how likely we are to succeed at the same task ourselves (that is, we think we are likely to fail too) [8].

Focusing on how we observe others and the effects of these observations has received a lot of attention in research. The individuals observed in this manner have been called *role models*. But what if we switch the perspective of studying this phenomenon, from us being the observers to us being the one observed; that is, what if *I* am the one representing an example (modeling something)? Knowing that others may observe and emulate me, or be discouraged from trying, different questions arise: How can I think about what I

¹This quote has been attributed to several people, including Gloria Steinem, Sally Ride, and Marian Wright Edelman [45].

model and what I could model? For whom am I modeling, and with whom? To what extent am I aware of my modeling, and how intentional is it? Why should I think about this?

Different people will have different answers to these questions, as what is seen as possible or desirable to emulate or avoid emulating is affected by the social contexts that these individuals are part of, and the norms within these contexts, i.e., unwritten rules that tell us what is considered common or standard.

My research focuses on questions similar to the above, in the context of computing and engineering (as explained in Section 1.2), particularly in higher education. I want to better understand how people in these disciplines (mainly, but not exclusively, educators) experience being role models for others (mainly, but not exclusively, students). I chose to focus on educators as role models but also considered other individuals, such as other professionals or students being role models for other students. What do these individuals perceive that they can model? Considering the particular context of computing and engineering, how do different unwritten rules of what is seen as standard (such as computing being technical, and rational [101]) affect what kinds of professionals are perceived as worth imitating? How can educators make use of theories in ethics to think about what they role model and why? To scaffold these reflections, I have developed a framework based on experiences reported by educators and literature in different research areas, such as economics or different disciplines within Science, Technology, Engineering, and Mathematics (STEM).

The kind of impact I aim to have by addressing these kinds of questions (which are more detailed in Section 1.3) is to contribute to theory-based reflections on role modeling as part of contexts where role models are present and representing ways of being and participating in computing and engineering, such as pre-and in-service teachers education, study program design, and conference organization. By ways of being and participating, I refer to both what falls within standard perspectives and understandings of the disciplines and to what is less present in these contexts, e.g., emotions and types of care (such as caring for other humans or the planet, more detailed in Section 2.5).

An outcome of these reflections that I find personally important is taking steps toward broadening participation in computing and engineering. By this, I mean not only efforts in DEIA (Diversity, Equity, Inclusion, and Access) of marginalized groups in the disciplines but also to have a more diverse set of ways of being and participating in computing and engineering seen as legitimate.

1.1 Different ways to use this thesis

This text is a compilation thesis in the academic Swedish tradition: a set of research publications accompanied by a *kappa*. A *kappa* is a text that helps the reader understand the compiled publications and their connection. While informing the reader is one of the aims, this thesis is one way to show the academic community that I have acquired certain skills and knowledge. It is also a way for me as an author to reflect on my learning throughout the duration of my Ph.D. studies, and on how what I have learned has, in turn, affected me.

Thus, there are different audiences for this text. Some may be particularly interested in, for instance, the findings or the ethical considerations, and may want to skip some other chapters or sections. Some, as educators, may prefer to directly look at how to make use of the work presented here when applied to teaching and other contexts, as described in Chapter 6. Having particularly new Ph.D. students in mind, I have also more explicitly written some of my decisions and my sources supporting them. For instance, in Chapter 4, I have explained what a positionality statement is, why I include it, and which material I have used to structure it; in Chapter 3, I include context, definitions, and sources used in my considerations of ethical approaches and trustworthiness in this thesis. In terms of language, this thesis is written in an academic style in the computing and engineering research areas. For other formats to learn about this work, it is, of course, always possible to contact me for videos and other material where I have explained my work to different audiences.

As this thesis can be used for consultation of certain parts or read as a whole, I include a description of its structure:

- In Chapter 1, I put my research in the broader context (in particular, within computing education research), explaining my aims and the research questions I address. I then describe the characteristics of the publications included in this *kappa*.
- In Chapter 2, I summarize research in, e.g., role modeling and care ethics that contextualize and/or have acted as theoretical lenses through which to approach my work.
- In Chapter 3, I describe which approaches I used for data collection and analysis, and my main ethical and trustworthiness considerations.
- In Chapter 4, I motivate and write a positionality statement, as I understand that who I am as a researcher affects how I do research and how my research affects me and others.
- In Chapter 5, I detail and discuss the findings of this work.
- Chapter 6 is targeted mainly at practitioners: educators, conference organizers, or anyone in a power position in situations where there are potential role models. It includes practical examples of how to use the work in this thesis.

- In Chapter 7, I describe the contributions to research and practice that I make with the work described in this *kappa*.
- In Chapter 8, I include different avenues for future work.
- In Chapter 9, I reflect on what I would like the reader to take with them after reading this thesis (or after focusing on Chapter 6, in the case of, for instance, practitioners).

1.2 Computing and engineering education research

Why is this thesis in the context of computing and not of, perhaps more widely known, computer science? Computer science, with branches such as artificial intelligence, computational complexity theory, and formal languages, can be considered a part of computing [139], one of the seven subfields of computing together with computer engineering, software engineering, information systems, information technology, cybersecurity, and data science, as categorized in the ACM (Association for Computing Machinery) 2020 curricula recommendations. Computing is thus an umbrella term for a wide variety of branches, accommodating new additions as related disciplines rapidly emerge [6].

Tedre’s work explains in detail three traditions in computing, namely mathematical, scientific, and engineering [139]. These traditions sometimes are intertwined. Tedre and Sutinen [140] advocate for this knowledge of computing as something that should be transmitted to students, regardless of how the educator positions themselves within these traditions; educators in computing should know about these traditions, the overlap and differences among them, and how a professional in computing usually positions themselves in more than one of these traditions throughout their work.

Caring about teaching and what students in computing learn, looking for scientific evidence to bring to decision-making in the context of computing education, is one of the ways in which an academic may find themselves interested in Computing Education Research (CER) [29]. While it is hard to date the start of computing (at the very latest in early 1900 [139]), CER is a far more recent discipline, as summarized by Daniels et. al [30]. The first computing-focused conferences were held in the US in the late 1960s, spreading to Europe and Australasia in the 1990s. It was not until the early 2000s that discussions on CER as a discipline, what it is, etc. were presented, e.g., first in a panel at a conference and later in handbooks. However young, CER has been found a legitimate discipline [30]; it is not a subfield of education, as it is not only education but also computing [84, 30]. CER is an example of Discipline-Based Education Research (DBER), and CER work is often presented in Engineering Education Research (EER) venues, sometimes being difficult to distinguish between CER and EER [30].

As a discipline, CER makes use of theory. CER draws from theory and methods from other disciplines, such as education, psychology (such as social cognitive theory described in Section 2.1), and sociology [30, 103, 82, 113]. Discipline-specific theory for CER is needed [84]. To this day, there is an ongoing discourse on what constitutes theory [66] and theoretical constructs [83] in CER, and to what extent being strict on its use supports or hinders work in CER [96].

One way of categorizing what is studied within CER is presented by Malmi et al. [83] as different topics:

- learning/understanding,
- study choice/orientation,
- performance/progression/retention,
- learning behavior/strategies,
- contents/curriculum/learning goals,
- emotion/beliefs/attitudes/self-efficacy,
- teaching/pedagogical content knowledge,
- assessment/self-assessment,
- computing education research,
- errors/misconceptions,
- perceptions of computer science/computing.

This thesis touches upon many of these topics, such as how educators perceive that they act (including displays of emotions) and what is part of computing, and how CER and related disciplinary identities are perceived.

Higher education has been the main focus for context in CER and EER. However, this is rapidly changing, making room for informal learning, education at lower levels, etc. [30]. In this thesis, most of the literature and all of the data are on higher education. In this context, educators have a noticeable position from the student's perspective. In educator, I include various terms used by different institutions worldwide, which can have different levels of power and responsibility, from that such as faculty, instructors, lecturers, or course-responsible teachers to teaching assistants and student helpers.

1.3 Aims and research questions

As we are all in situations where we can be observed, we are all potentially role models. This is so regardless of whether we are aware of this potential or not, whether it is our intention to be regarded as role models or not. In certain roles, we are more noticeable and get more power. One such role is that of an educator. I want to understand how they perceive their own role modeling and to scaffold nuanced reflections and discussions that contribute to educators expanding their thoughts and perspectives of their role modeling. The scaffolding can be aided by using a framework to have a shared vocabulary and structure.

Besides how educators represent knowledge and skills that receive much attention in computing (such as programming skills, see for example [6]), I want to look deeper into how educators understand their modeling aspects and achievements that in previous research have been found lacking in computing and engineering. This includes ways of being and participating in the disciplines that are not focused on the technical, logical, and rational [101, 115, 36], such as being interested in how technology impacts society [110].

These representations are not limited to content-related examples or even exclusively positive ones. Role models can represent many aspects of being an academic and what we may transmit to others through our example in how we navigate these contexts, dealing with systemic barriers and cultural obstacles. Thus, I want to understand in which situations and for what reasons educators perceive that they are prevented from (or, simply, do not think there is a need to) role model certain achievements and aspects, and may instead role model others that could be perceived as negative instead.

It is my hope that these reflections and discussions (in, for instance, pedagogical education) lead to positive change in individuals and systems, taking steps towards broadening participation in computing and engineering; this refers to 1) efforts in DEIA (Diversity, Equity, Inclusion, and Access) of marginalized groups and 2) that a more diverse set of ways of being and participating in the disciplines are seen as legitimate. I have aimed to steer away from a deficit-based approach, i.e., where the problem is seen as marginalized groups “lacking” something and having to compensate for it; rather, I would like this thesis to be an invitation for educators of all backgrounds, interests, etc. to share the responsibility of contributing to a more diverse computing/engineering education culture through their role modeling.

With these aims, and in particular the creation of a framework for role modeling in computing and engineering education, I have the following overarching research question (ORQ):

ORQ: *How can role modeling in computing and engineering education be conceptualized, as seen from the role model's perspective?*

This is explored more concretely by addressing the following research questions (RQs):

- RQ1: What can educators in computing and engineering role model?
- RQ2: What are obstacles that affect what is role modeled by educators in computing and engineering?

Below there is a more detailed description per publication included in this thesis, including RQs addressed and research purposes [82].

1.4 Publications connected in this thesis

This thesis is comprised of five publications. Table 1.1 shows a summary of information about each paper, including the research questions described in

Section 1.3, that will be expanded per chapter as described in Section 1.1. Here I briefly describe the types of papers according to characteristics such as publication venue and research purpose dimensions as categorized by Malmi et al.'s [82]. In order to better understand the writing process, Figure 1.1 shows the timeline for the main work included in this thesis. The figure does not include other work by me, such as that listed in Related Work at the beginning of this thesis. First, I conducted interviews with teachers and wrote Paper I. Paper II and III were written in parallel. They were followed by Paper IV, a journal paper being reviewed after resubmission at the time of this writing. We collected data as a multinational survey and wrote Paper V. Further details on data collection and its analysis can be found in Chapter 3.

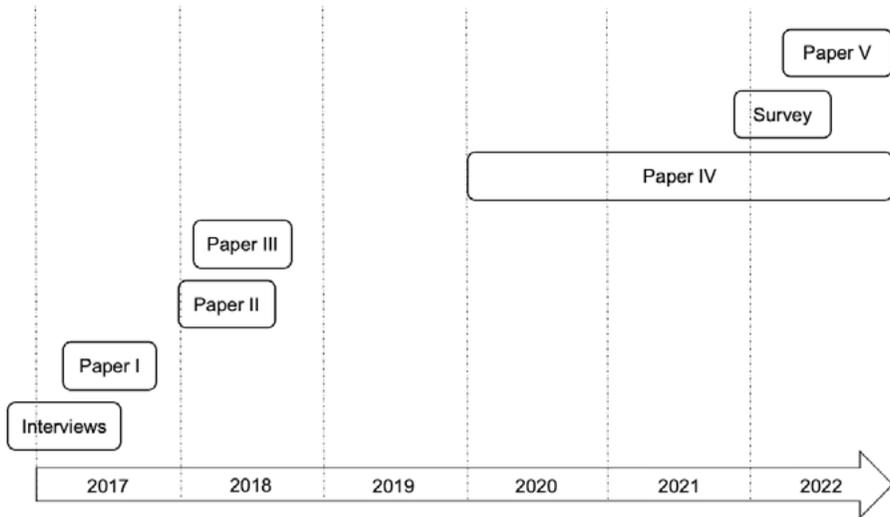


Figure 1.1. Timeline for data collection and paper writing, including analysis, for the main work included in this thesis (other work is not represented here).

In terms of publication venue, except for Paper IV all papers are part of conference proceedings in CER and EER. This is in line with CER culture, in which (following the tradition in computing) valued publications are not only in journals but also in conferences in CER and EER [113, 30]. These conferences are usually sponsored by major professional organizations, such as ACM, IEEE² (in engineering), and ASEE (American Society for Engineering Education), which has a strong presence in the USA. The publications in this thesis are as follows:

- Paper I is a short paper published in a single-track CER conference, ACM Koli Calling, annually held in Koli, Finland.

²While IEEE stands for the Institute of Electrical and Electronics Engineers, this name is outdated, as the association currently has members from other disciplines. IEEE decided that it should be referred to by its acronym only (see <https://www.ieee.org/about/ieee-history.html>).

- Papers II and III are full papers published in a multiple-track EER conference, ASEE/IEEE FIE (Frontiers in Education), held in the USA except for some exceptions allowed every five years.
- Paper IV is a journal paper revised after feedback from reviewers for the Taylor & Francis' European Journal of Engineering Education (EJEE).
- Paper V is an ACM ITiCSE (Innovation and Technology in Computer Science Education) working group (WG) report, which is a special case of a publication connected to a conference. A WG in this context refers to a project where 5-10 researchers, coordinated by 1-3 WG leaders, work online for several months before the ITiCSE conference (almost always held in Europe), then intensively in-person/hybrid during the three days prior to the conference, and they revise their draft for a few months after. It is a longer publication than the rest of the proceedings, yet it is still associated with the conference³. As there is a call for participation per group, WGs contribute to community building by providing a platform for researchers to meet new collaborators [88].

Paper I is a description of a pilot study, using five out of nine interviews with teachers at the Department of Information Technology at Uppsala University. The research purpose is descriptive-human system, describing an existing system [82]. I used a phenomenographic approach (explained in more detail in Section 3.2), where I study a phenomenon (how teachers experience their role modeling for their students) and I present their different levels of understanding of this phenomenon as a group of categories. These categories are organized in a hierarchical structure, from the least complex level of understanding of the phenomenon (role modeling) to the most complex. For instance, the least complex levels included role modeling as a focus on transmitting subject content and interest in it, while one of the more complex levels referred to perceiving student cohorts in a heterogeneous way and differently affected by role modeling. All these findings were used as a base for the analysis in Paper II.

In Paper II, I present a framework for role modeling. The research purpose is formulative-model, presenting a simplified model of a more complex phenomenon [82]. The aim was to have a basis to discuss the “what”, the “who” and the “how” of role modeling, especially as an educator in computing and engineering. It makes use of the theory from Paper III and literature on role modeling from different research fields, to conduct thematic coding analysis on the same interviews as in Paper I and consider the findings of said publication. Examples of how to use this framework are shown in Chapter 6. I have presented and discussed this framework in interactive group sessions (see RI, RII and RIII in Related work), besides at individual presentations in different invited seminars and conferences outside of exclusively CER and

³For more information and examples see <https://sigcse.org/events/workinggroups.html> and consult [88].

EER contexts. These include the ESERA (European Science Education Research Association)⁴ conference (see RV in Related work) and NU (*Nätverk och Utveckling*, “Network and Development”), a Nordic conference on higher education.

In Paper III, we use role modeling and identity theory combined with history of computing to discuss context (social contexts, cultures and norms) as a factor for role modeling in computing, affecting which disciplinary identities are perceived as legitimate. The research purpose is evaluative-critical, aiming to transform systems, that are also described (descriptive-human system) [82]. The analysis is done through argumentation, where “conclusions are reached through arguments presented by the author(s).” [82, p. 7]. Data is only used to illustrate some of the points stated, and it had been previously collected for other studies, i.e., the teacher interviews used for Papers I and II, and the student data from Peter’s Ph.D. thesis [110]. This paper was also part of the symposium on disciplines (see RV in Related work), as part of the ESERA conference (as explained for Paper II above).

Paper IV, inspired by previous work with Kristina von Hausswolff (see Related work RVII), is on ethics and role modeling. The research purpose is descriptive-other [82], bringing together role modeling literature with theories in ethics that focus on personhood, i.e., virtue ethics, care ethics, and ethics of freedom. As in Paper III, argumentation is employed to focus on the “why” and “how” of role modeling as a teacher: If I, as a teacher, may be emulated, how should I behave? Why should I (not) model something? The answer depends on the ethical lens used. These lenses provide overlapping and conflicting views to analyze a teacher’s role modeling. The implications of this are also listed in Chapter 7. In the paper, we write about teachers caring for someone or something, about virtues, etc., and we include a reflection on whether these aspects are reflected in the framework described in Paper II.

The research purpose for Paper V is descriptive-human system [82], describing how, why, and where/when educators perceive that they show certain kinds of emotions, types of care, and professional competencies. Data was collected as 199 valid responses to a multinational survey, which included Likert-scale and open-ended questions analyzed quantitatively and qualitatively, respectively. The findings of our exploratory study show the need for scaffolded reflections on the “what”, the “how” and the “why” of role modeling as an educator, using a combination of different frameworks for role modeling, care, emotions and professional competencies that brings light to modeling aspects and achievements outside of the technical, theoretical and rational.

⁴More information at <https://www.esera.org/>

Paper	Main RQ(s) per	Type of pa- system	Background	Data from	Data collec- tion	Analysis
I	RQ1	Descriptive- human system	Role modeling literature	Computing teachers	Interviews, 5, Sweden	Phenomenography
II	ORQ, RQ1	Formulative- model	Role modeling literature	Computing teachers	Interviews, 5, Sweden	Thematic content analysis
III	ORQ, RQ2	Evaluative- critical, descriptive- human system	Identity theory, History of computing, Role model- ing literature	Computing teachers and students	-	Argumentation (empirical data used to illustrate points)
IV	ORQ, RQ1	Descriptive- other	Virtue ethics, care ethics, ethics of freedom, Role modeling literature	-	-	Argumentation (no empir- ical data used).
V	RQ1, RQ2	Descriptive- human system	Role modeling literature, care ethics, emotions, professional competen- cies	Computing teachers	Survey, 199, Multina- tional	Thematic content anal- ysis, descriptive statis- tics, group comparisons (Kruskal-Wallis)

Table 1.1. *Main information about each paper in terms of research purpose and approach.*

2. Theoretical background and lenses

In my work, I have used several theoretical lenses, as explained in this chapter. Besides describing these lenses, I also refer to some work connected to what is presented in this thesis. The idea of how we learn from observing others comes from social cognitive theory [8], which is connected to the concept of role model. I describe some literature on the definition and characteristics of a role model, particularly in STEM. Putting role modeling into that context (and besides the history of computing described in Section 1.2), we made use of identity theory and how it and ethical theories such as virtue ethics, care ethics, and ethics of freedom can help guide our role modeling. Work on professional competencies and emotions ties well with care, and their connection with role modeling as educators in computing and engineering education.

2.1 Learning from observing others: social cognitive theory

In the context of education, role modeling can be analyzed by using learning theories such as social cognitive theory [1]. While I do not use this theory directly in my work, I include this section as a brief explanation of the main points relevant for my work, to contextualize what is presented in this thesis.

In Chapter 1, we saw examples of aiming to emulate or avoid imitating a behavior displayed by another individual. According to social cognitive theory, we do not just automatically emulate everything that we observe; rather, we choose what to do based on different factors. In the examples in Chapter 1, we notice behavior that we observe and aim to emulate (presentation competencies) and aim to avoid (joking attitude). We may also observe other traits, behaviors, etc., that we have no interest in either emulating or avoiding. To make these decisions, we reflect on what goals we have, who we can observe in what situations, and how we consider the outcomes in connection to our goals.

Bandura claims that, as individuals, we are “agents of experiences rather than simply undergoers of experiences” [10, p. 4]. This acting with intention or *agency* is central in social cognitive theory. Whether the outcomes of the action(s) are the expected ones or not, it is the intention, the commitment to make something happen, that is central here. Bandura [10] explains the distinction between three times of agency: personal, proxy, and collective. Personal agency is related to the choices we as individuals can make to affect

desirable outcomes. When we need others to act for us, we exercise proxy agency. For instance, for systemic change, outside of our power or knowledge, we need those in power to use their position to influence action toward our desired outcomes. Less positive use of proxy agency relates to situations where we may come to others for something we could have faced ourselves, which may hinder our development. Lastly, when we are part of a group (and we always are part of social contexts), acting together on a joint belief, we refer to collective agency [9].

According to social cognitive theory, as summarized by Schunk [134] focusing on the work of Bandura [8], we learn not only by doing (enactive learning) but also through observing others in their social environments (vicarious learning). As in the examples above, when we pay attention to someone behaving in a certain context, we can evaluate the potential outcomes of this behavior for this person, how we value each of these outcomes, and thus how we want to act ourselves accordingly, considering our circumstances and capabilities, and how they are shaped by the contexts we belong. This process of observing and reflecting is particularly useful to save us from experiencing undesired consequences ourselves. After observing someone modeling a behavior, etc. that we believe will lead to a desirable outcome, we can emulate them; then we practice independently so that we develop our understanding in a wider sense (and not just the specific example we observed), and we adjust as needed [154]. Agency involves our being able to choose what we emulate or avoid, what we think will lead to desirable outcomes, rather than copying everything that we observe.

However, this is not a simple phenomenon: social cognitive theory presents a system where the environment, our behaviors, and personal beliefs, competencies, etc. interact in a complex manner. As posted by Bandura [8, 9, 10] and summarized by Schunk [134], we interpret the outcomes of our actions, shaping our environment and personal factors, affecting in turn our behavior.

Vicarious learning is one of the factors, besides, e.g., our performance, and social persuasion, that affects self-efficacy [9]: our perceived ability to succeed. Observing someone similar to us succeeding can increase our self-efficacy, whereas seeing them fail can decrease it [133].

In educational contexts, a student may observe e.g. teaching staff or peers, and decide what to imitate or avoid becoming. Gladstone and Cimpiun refer to these individuals as role models, as “individuals who can positively shape a student’s motivation by acting as a successful exemplar.” [45, p. 1].

Context plays a significant role in social cognitive theory. In this thesis, role modeling is considered in the context of computing and engineering education, as described in Section 1.2. In particular, we show a complex interpretation of the agency to choose what we emulate or avoid copying by taking into account that context matters.

Social cognitive theory has been the precursor of other theories connected to role modeling. An example is social cognitive career theory (SCCT), which

aims to support understanding of the career development of students and professionals. It combines perspectives on career-related interest, choice, and performance [71]. In the context of computing education, SCCT can be used to study, for example, factors to attract more students from marginalized genders in some parts of the Western world (in this context, those who are not cisgender¹ men). One of these groups of factors is social support, where students refer to and ask for role models [3].

2.2 Role modeling

In this section, I give an overview of previous research that has aimed to define role modeling and how having a role model can affect students in CER and EER. I have built on some of this work, as used in Chapter 5, and present here how my thesis contributes to this body of knowledge.

As a well-known term, role model is loosely defined and inconsistently used [43, 94]. Participants in research studies may have different interpretations of it, leading to misunderstandings [20]; studies may use the term without a definition and/or in connection to similar (but not equivalent) terms, such as mentor or hero.

Mainly, one can think of role models in two ways: 1) as representing a particular role, (in engineering used in, e.g., models for early career engineers [28]), or, 2) as seen in Section 2.1, as someone representing *part of* a role or a way to achieve a goal, something that can be observed and considered for emulation. This thesis focuses on the latter. To discuss role modeling, I take as a point of departure Gladstone and Cimpian’s definition of role models “as individuals who can positively shape a student’s motivation by acting as a successful exemplar.” [45, p. 1].

2.2.1 Some conceptualizations and other research on role modeling

Research in education has mainly focused on “uncovering the mechanisms by which imitation occurs (e.g., the aspects of role models that make them more or less effective and identifying the outcomes associated upon imitating the model” [1, p. 1]. For instance, Morgenroth et al. conceptualize role models in terms of how they influence goals and motivation in three different ways: “(a) they [role models] show us how to perform a skill and achieve a goal — they are behavioral models; (b) they show us that a goal is attainable — they are representations of the possible, and (c) they make a goal desirable — they are

¹Cisgender, or just cis, is an adjective indicating that the person identifies as the same gender as they were assigned at birth. If they identify as a gender different from that assigned at birth, the adjective trans can be used as an umbrella term.

inspirations.” [94, p. 487]. This is similar to how McCullough presents role modeling, where reasons for engaging with role models can be that they are motivational (“living evidence that certain achievements are possible” [89]) and/or inspirational (based on Social Cognitive Theory (SCT) as described in Section 2.1 and “comprised of emulating values, attitudes, skills, thoughts, and behaviors that are considered valued by the individual” [89]).

There are frameworks that conceptualize how role models are chosen and used. Gibson [42, 43] gives examples of close versus distant role models, depending on whether the role model is in the network of the person observing them. One may observe up or down, i.e., the different directions in the career/affiliation hierarchy. For instance, having one’s boss as a role model would mean having close and up role modeling. Depending on whether one observes a particular trait or the person more generally, Gibson distinguishes between global and specific role modeling. With this conceptualization, Gibson wants to also bring attention to the fact that role models, contrary to previous work, are not only for individuals who are early in their careers but rather for all career levels (with the type of role models changing over time). Another example of work on how professionals use role models is McCullough’s thesis, which focused on levels of professional success and how this affects the use of role models [89]. This conceptualization also includes types of connection to the role model, e.g., from relatives and professional relationships to historical or fictional figures.

It makes sense, then, that these definitions and conceptualizations are formulated from the perspective of the person observing the role model. After all, no interaction is needed for someone to be considered a role model [42, 43]. It is the person observing, making the decision on how to act based on their observations and values, that makes someone a role model (or not). Thus, a more encompassing definition of role model than the ones previously used in this thesis is Gibson’s, who defines role models “as person(s) an individual perceives to be similar to some extent, and because of that similarity, the individual desires to emulate (or specifically avoid) aspects of that person’s attributes or behaviors. Individuals attend to role models as possible exemplars of the professional skills and personal attributes needed to achieve desired goals.” [42]. This definition is closer to SCT in that the observer does not necessarily emulate the role model but may, instead, choose to purposefully avoid becoming this person.

Lockwood et al. [76] refer to this kind of role modeling as negative role modeling, when an individual represents something that should be avoided in order to achieve a goal. For instance, Student A observes Student B, who is partying the night before an exam and consequently fails it; Student A decides to avoid for themselves Student B’s behavior, in order to be a successful student. Lockwood et al. [74] argue that we have different predispositions to look for positive versus negative role models. This may be affected by culture, where individualistic cultures may tend to search for positive role models (to

develop as an individual) and collectivist cultures may focus on negative role models (to avoid harming the group) [76].

Gibson [42] also refers to the similarity between the role model and observer. While this is often understood in terms of social identities, especially for marginalized groups (e.g., women need women role models), this similarity has been studied in terms other than demographics, such as identification with the discipline [45]. When we observe our (positive) role models, we need to be able to think that we can become like them (in that aspect or achievement that we are focusing on) with time and/or effort [75].

2.2.2 Role modeling in CER and EER

In CER and EER, if we consider educators as the role models and students as the ones observing them, then research tends to focus on how the students may benefit from observing their educators and other role models, and on what they observe. For instance, increased motivation is one of the potential outcomes of having a role model (for a review, see [45]), besides increased academic achievement [155] and self-esteem [153]. For more efficient role modeling in engineering education, aiming to increase student motivation, Gladstone and Cimpian [45] recommend that we portray role models as being competent and successful, meaningfully similar to the students, and their success as attainable. They also recommend prioritizing exposing students to role models from marginalized groups in STEM².

This focus on marginalization can be seen in literature reviews such as Olson & Martiny's [100] on gender and counterstereotypical role models, or Lawner et al.'s on ingroup and outgroup role modeling [69]. As a result of this kind of research, many initiatives in computing and engineering strive to provide students (in particular, from marginalized groups) with role models, e.g., [7, 15, 135, 72, 147]. For an efficient organization of these kinds of activities, frameworks such as Taylor-Smith et al.'s for gender [138] can be used.

Other research has looked at students' aspirations in computing and how role models may affect these [151] or students' likelihood of participating in computing education [68]. There is also work on role models (or lack thereof) for professionals (rather than for students), e.g., for women working in IT [25]. Perhaps as a bridge between the professional and the educational world, authentic teaching situations in engineering can be interpreted as educators being role models of practices in the professional world [73, 55].

Outside of role modeling to broaden the participation of marginalized groups in computing and engineering, we can look at educators in general as role

²The dominant group in CER and EER in the parts of the Western world that dominate research is usually described as cisgender white straight able-bodied men (to name a few dimensions of privilege). Notice, though, that this is only in specific parts of the Western world and, as usual, context matters to understand marginalization in different settings.

models for students in general. Taking computing as an example, there seem to simultaneously be some quite broad and very concrete expectations of how a teacher should be a role model. A teacher may be expected to be a role model “24/7” [78], and their role modeling may go from transmitting interest in computing-related skills [146] or ethical behavior connected to the discipline [37] to more personal choices such as their dress style [85]. An example of the kind of motivation they can inspire among students outside of interest in the subject is, e.g., that the students study abroad [60]. These scattered examples are not enough to give an overview of how educators can reflect on their role modeling for their students in computing and engineering education.

In summary, previous research focuses on the perspective of the person observing the role model. This thesis shifts that perspective, focusing instead on the perspective of the role models. While the latter are considered in this thesis as mainly educators, in line with previous research in EER [45], others can also be role models, including students (more similar to approaches such as those described by Schunk for education in general [134]). Another approach in this thesis that differs from some previous work, where role models are part of initiatives with very clear and concrete goals to motivate and inspire students and others, is the additional focus on unplanned or unintentional role modeling.

2.3 Identity

Identity is a complex concept with many different definitions and uses [114], sometimes used interchangeably with other not equivalent concepts, such as sense of belonging [61]. Gee, as cited by Carlone and Johnson [23], defines identity partly as: “the ‘kind of person’ one is seeking to be and enact in the here and now” [40, p. 13]. Identity theory is used in science education research (for a recent review, see [31]), in EER (see, e.g., literature reviews [93, 102, 141]) and in CER (see, e.g., Kapoor and Gardner-McCune’s categorization on identity in undergraduate education [61]). All this work captures many ways in which identity can be conceptualized and used as a lens.

As a theoretical lens, identity is well-suited to analyze marginalization, e.g., who is seen as part of an (academic) community [114, 23], looking at what “kinds of people [are] promoted and marginalized by science teaching and learning practices” [23, p. 1189]. In science education, Carlone and Johnson propose a framework [23] to understand what a strong science identity consists of (particularly when considering gender and ethnicity). They present three interconnected dimensions of identity: competence (knowing what to do and how), performance (showing that competence to others), and recognition (by oneself and by others, as a response to the performance of competence). I consider this perspective as connected to role modeling, in that individuals in STEM may be recognized as positive role models because they are perceived

as competent [45] or may not be recognized and risk being perceived as negative role models. Carlone and Johnson's framework also shows identity not only as defined by the individual but constructed with others, such as those who give recognition.

Pozzer and Jackson [114] have developed a framework that presents identity as something possessed by the individual or as something that is negotiated in interaction with others, based on the use of the concept in science education research. In their review of the literature, they saw that identity is not seen as something completely stable. Rather, it is dynamic to different extents. Possessed identity is closer to stability but change is still possible, although it may happen at different speeds (including rather slow). The dynamism is higher when identity is seen as negotiated.

Identity as possessed is towards the more static interpretation. A well-known example is that of having a core identity as defined by Gee [41], one that the individual takes with them to different contexts and that is relatively stable, fixed to some extent regardless of context or interaction. Multiple identities, where one or more of them are more salient depending on the context, are another example of identity as possessed (and not incompatible with the concept of core identity). These can be connected to roles in society, e.g., teacher, parent, and student.

Identity as negotiated (or performed) puts the focus on how we continuously are an "other" to someone else, and we continually negotiate identity in different contexts with different others, i.e., it is constantly reconstructed. As Pozzer and Jackson state, "To construct our identities we need *to be seen and accepted by others* as a certain type of person" [114, p. 221], and others would do the equivalent process for them with us.

There are several concepts and topics to narrow down identity research. Teacher and student identity are common foci in science identity research [114], such as in projects studying its development. An example in CER would be computing students' identity development during their undergraduate education [110]. In Paper III, we use the concepts of disciplinary and professional identity, which can again be defined in different ways. In this thesis, disciplinary identity encapsulates the ways in which an individual relates to the discipline and transmits this to others; professional identity is connected to how we negotiate different aspects (private, professional) of our lives [99], while making use of disciplinary knowledge in complex social situations. To discuss these negotiations we also refer to the potential role model's level of influence, understood as their capacity to effect change in their environment.

2.4 Professional competencies

The concept of competency has various interpretations. In dictionary definitions, competency is described as knowledge and/or skills, e.g., the "posses-

sion of sufficient knowledge or skill” [91] or “an important skill that is needed to do a job” [21]. In CER, dispositions are added to the definition of professional competency. Sabin et al. [126] present professional competencies as a triad of 1) knowledge, 2) skills, and 3) dispositions, all in a specific context for a specific task.

A disposition then “encompasses socio-emotional skills, attitudes, and behaviors that characterize the inclination to carry out tasks and the sensitivity to know when and how to engage in those tasks” ([109] as cited by Raj et al. [115, p. 136]). This definition of disposition shows a connection to emotions in CER and EER, a research area described in this chapter. Defining dispositions helps students understand “what is expected of not just the products of their work but the human, interactive aspects of their work” [36, p. 6]. This aligns with Riley’s call for engineering education to support students and others in becoming professionals who consider the social and ethical aspects of their work [122].

Examples of professional competencies from this perspective are intrapersonal competencies (related to intellectual openness, work ethic and core self-evaluation) and interpersonal competencies (connected to leadership, and teamwork and collaboration). Cognitive competencies are related to content knowledge and skill learning and development [115].

Besides these kinds of competencies related to the practices in the disciplines of computing and engineering, educators may also model competencies related to teaching. An example can be seen in the multidimensional adapted process model of teaching (MAP) framework, which includes competencies related to content knowledge, emotional competency and professional well-being, to name a few [92].

2.5 Care ethics

As a response to ethics focused on principles and what was seen as a masculine perspective, Carol Gilligan advocated for a feminist perspective, care ethics [44]. Care ethics (or ethics of care) is not focused on principles but rather on relationships between the one doing the caring (the carer) and the one receiving the care (the cared-for) [144]. As Noddings [97, p. 188] describes it:

[...] the ethic of care gives only a minor place to principles and insists instead that ethical discussions must be made in caring interactions with those affected by the discussion. Indeed, it is exactly in the most difficult situations that principles fail us. Thus, instead of turning to a principle for guidance, a carer turns to the cared-for. What [do they] need? Will filling this need harm others in the network of care? Am I [the carer] competent to fill this need? Will I sacrifice too much of myself? Is the expressed need really in the best interest of the cared-for?

This set of questions leads us to many of the characteristics of care that are relevant to this thesis and are further explored below.

Care ethics has been advocated as needed in computing and engineering [112, 122]. Riley's call to action refers to how "we (feminists doing engineering ethics, engineers doing feminist ethics)" [122, p. 203] need to make use of feminist lenses such as care ethics because engineering is related to political matters through its presence in military action, and its impact on social, economical, and environmental sustainability [122].

Tronto described care as four phases [144] that are interconnected and may be carried out in a non-linear order [34]. Mariskind [86] applies these phases to teaching in higher education from the perspective of teachers as carers:

- Caring about: the teacher recognizes that care is needed, e.g. for a student.
- Taking care of: the teacher takes responsibility for the care and reflects on approaches to meet the needs identified.
- Care-giving: the caring is done, i.e. the needs are addressed as much as possible within the circumstances.
- Care-receiving: confirmation by the cared-for that the needs have been met.

For the first two phases, we can consider the question above: "What does the cared-for need?". The carer may be tempted to be a *virtue carer*: someone who focuses on the assumed needs of the cared-for, needs that the carer assumes but has not discussed with the cared-for, rather than also including the expressed needs of the cared-for, the ones that the cared-for has made apparent in some way. An example in education is a teacher who thinks that they know what the student needs (e.g., what should be taught according to the curriculum) but is oblivious to the needs that a specific student may express (e.g., hatred of the subject that puts a barrier towards learning) [98]. The teacher should engage with the student to properly identify their needs, not only assumed but also expressed.

Preconditions to be able to carry out the phases of care include time, material, resources, knowledge, and skill [34], e.g., considering whether "Am I [the carer] competent to fill this need?" Sometimes the expressed needs of the cared-for may not be possible to meet by the carer because, e.g., they are deemed not beneficial for the cared-for, the question "Will I sacrifice too much of myself?" would have a positive answer, or of systemic barriers. Care is not about meeting every expressed need but about maintaining the caring relationship, e.g., discussing with a student why the need is not to be met and what alternatives could be good instead [98]. Systemic barriers may be encountered, producing a system that does not properly care about and for the student. Then the educator may become a care-advocate, pushing for change in the system that leads to an environment where the student's needs can be met [86].

The cared-for will confirm in some way that their needs have been met. This is not necessarily by expressing gratitude. For instance, a student may ask further questions, signaling that their previous needs have been addressed [98].

When considering related questions such as “Will filling this need harm others in the network of care?” and again “Will I sacrifice too much of myself?”, we see that there are different types of care that need to be balanced. In this thesis, we focus on care for oneself, care for other humans (such as students, colleagues, and family), care for other living beings (animals, plants), care for non-living beings (such as devices), and care for the planet.

Noddings refers to equal and unequal care relationships [98, 34]). In equal relationships, like friendships, both people involved switch roles between carer and cared-for. In unequal ones, this is not so. For instance, a teacher will always be the one caring for a small child [98]. As examples in computing and engineering, equal relationships can be explored using care ethics in, for example, hacker communities that aim to be welcoming to all [143]. Unequal relationships include not only teacher-student but also, e.g., researcher-participant [142] or PI (Principal Investigator)-colleague, although the last two examples can include a switch of caring roles at times, such as the participant caring for the researcher.

It is important to address who are carers and important factors in the relationship with the cared-fors. While care has been initially associated with women, care ethics is not thought to be restricted to that gender alone [97]. It requires competencies associated with both femininity and masculinity, e.g., attentiveness, risk-taking [86]. In practice, however, it is not men from dominant groups who tend to do most of the care [145]. So, while unequal caring relationships imply that the carer has power over the cared-for, outside of that relationship the power that the carer has may be quite different.

In this thesis, I have used care, sometimes with others, mainly to:

- study role modeling of educators towards their students and others (Papers IV and V),
- consider my relationship with the participants in the interviews and survey for this thesis (as reflected on in Section 3.3),
- guide my leading of the teams working together to produce the papers included in this thesis (as reflected on in Section 3.3).
- frame my reflections on caring for myself in my role as a researcher (as reflected on in Section 3.3).

2.6 Emotions

Considering that emotions are studied in fields such as psychology, philosophy and neuroscience, there are many definitions of the term emotion. For instance, Lönngren et al. [81] refer to a study by Kleinginna and Kleinginna from 1981 [65] that aimed to synthesize over 92 definitions and give a con-

sensual one. Thus, while research in emotions in computing and engineering education should not be about finding yet another definition of the term [80], it is important to establish which interpretation of the term is used in studies [81]. In this thesis, emotions are studied in Paper V, where we use Pekrun's definition of emotion as "multifaceted phenomena involving sets of coordinated psychological processes, including affective, cognitive, physiological, motivational, and expressive components" [107]. Pekrun's work is the most cited in research on academic emotions in engineering education research [80]. In an educational context, the main foci of study for emotions can be students' emotions or educators' emotions. This thesis addresses the latter. This fits well in the gap presented by Lönngren et al., showing that most of the research on emotions in engineering education is in the context of higher education and particularly on the student perspective, with a few exceptions on the educators' perspective [81].

Depending on the type of affect the emotion produces, it can be labeled as positive or negative [106]. In Paper V, we refer to the emotions of fulfillment, enjoyment, hope, and pride as positive, while negative ones are confusion and frustration. It may be tempting to associate negative with emotions one should avoid. For instance, research on emotions in education has shown that "whereas positive emotions can fuel academics' motivation to excel in teaching and research, negative emotions can undermine their performance, derail their health, and generate burnout." [105]. However, negative emotions are necessary, for instance, for how we deal with the sustainability crisis [33].

Despite computing and engineering being seen as rational and logical [101], emotions are a necessary part of these disciplines [115, 36], and interest in this research area has dramatically increased recently, faster than emotions in education in general [77]. Lönngren et al. conducted a literature review [80] to study what had been addressed in engineering education. Research in this area is scattered, with authors being in several clusters that lack communication between them, and most authors wrote only one paper on emotions [80]. This corresponds to the finding that emotions tends to be a side topic in a wider research project [77], e.g., as barriers or facilitators to develop professional competencies [81]. In this thesis, emotions are one of the main parts of Paper V. They are presented as connected to professional competencies as an integral part of some of them.

As for research topics connected to emotions in engineering education, Lönngren et al. identified four dominant themes: academic emotions (especially performance-related anxiety), emotions and ethics (including care), emotional intelligence and other socio-emotional competencies (such as emotional regulation), and mental health (especially the lack of it) [80, 77]. In Paper V, we do not focus on a particular educational situation/context and study which emotions arise from it, e.g., when computing students receive feedback [62]. Instead, we investigate a set of emotions that educators may or may not show to their students, and their answers point to different reasons

and situations for these displays (or lack thereof). This means that participants could refer to any of these four identified areas, some of which were directly prompted, e.g., care for oneself, understood as well-being practices. With this approach, our exploratory study can spark more research using sociological perspectives, with emotions seen instead as social constructions, and looking at how emotions are connected to, for instance, addressing systemic barriers [81].

2.7 Virtue ethics

Aristotle, seen as the father of virtue ethics, claimed that good deeds come from good people. He believed that individuals should strive to develop virtues such as wisdom, magnanimity, or prudence. A virtue is a trait or quality that is practiced and developed until it becomes a character trait that is valued as good [5, 70, 51]. One way to develop virtues is by observing and emulating role models (also called exemplars) who embody them [5].

In more modern views of this Aristotelian thinking, it is highlighted that role models should be referred to as a representation of the virtues to be emulated, and not as individuals meant to be imitated as a whole. Kristján Kristjánsson [67] presents a case for this argument, arguing that educators should point out the difference to students, that it is important for the teacher to give moral reasons rather than a limited focus on good examples, even when students are early in their studies and may need support in understanding what the role models represent.

The idea of role models as the embodiment of virtues has been proposed for STEM too. Pennock and O'Rourke [108] argue that scientists are members of cultures (their disciplines) with shared values and rules. These may not be explicit and sometimes are taken for granted. They then refer to scientific virtues as the subset of virtues that specifically apply to the scientist and that can be embodied by role models, e.g., curiosity, perseverance, skepticism, honesty, and innovation. It is this concrete representation by role models that can support explicit discussions among the students of the values and rules in their disciplines.

Besides this view of positive role modeling, there are also anti-role models [70], which represent what we have defined as negative role models [76]: examples to avoid becoming.

2.8 Socialization and subjectification

Gert Biesta [14] presents education as having three interconnected dimensions of purpose:

- qualification: knowledge and skills, what is needed to perform the tasks demanded to practice the profession
- socialization: becoming an active part of a community by acquiring shared ways of being and doing, values and norms
- subjectification: being your unique self (as irreplaceable, rather than different), as opposed to socialization.

While the first two dimensions are clearly present in education, reproducing what is explicitly included (e.g., in the curriculum) and implicitly (e.g., hidden curriculum [149]), subjectification is less present. Subjectification is further defined by Biesta [14, p. 93]:

Put simply, what is at stake in the idea of subjectification is our freedom as human beings and, more specifically, our freedom to act or to refrain from action. This is not about freedom as a theoretical construct or complicated philosophical concept, but concerns the much more mundane experience that in many — perhaps even all — situations we encounter in our lives, we always have a possibility to say yes or to say no, to stay or to walk away, to go with the flow or to resist — and encountering this possibility in one’s own life, particularly encountering it for the first time, is a very significant experience. Freedom viewed in this way is fundamentally an existential matter; it is about how we exist, how we lead our own lives, which of course no one else can do for us. Put differently, freedom is a first-person matter. It is about how I exist as the subject of my own life, not as the object of what other people want from me.

Biesta writes about the teacher’s perspective, such as the judgments that they need to make in order to balance these three dimensions of purpose for the education of the students [13]. In this thesis, I have instead focused on how the teacher can role model this balance themselves. That is, teachers as role models of knowledge and skills (qualification), representing -or not-disciplinary norms (socialization), and managing to maintain their freedom to act or refrain from action (subjectification), being part of a community without giving up being their unique selves.

3. Research approach

In this chapter, I describe the research approaches I used, how I collected data, and conducted the analysis for each publication in the thesis. This is summarized in Table 3.1. In particular, I describe how I developed the framework described in Chapter 5. In the rest of the chapter, I also explain the main ethical considerations I made during my Ph.D. work, considering topic selection, participants, other researchers, myself in the role of researcher, and the broader context. I finish the chapter with considerations connected to trustworthiness.

3.1 Data collection

Two main data sets are used in this thesis: interviews conducted at a Swedish institution and a multinational survey. Table 3.1 contains a summary of how data were used for each paper.

3.1.1 Interviews in Sweden

Interviews and surveys are used to investigate that which is not observable [38]. Interviews allow the researcher to build rapport with the participants, especially with follow-up questions that contribute to a deeper understanding [38]. As I was interested in teachers' perceptions of their own role modeling, I decided to use interviews. In particular, semi-structured interviews gave me more flexibility to accommodate for unexpected understandings of role modeling expressed by the interviewees.

I aimed to have a diverse sample of participants in different ways. I interviewed nine teachers working at the Department of Information Technology at Uppsala University. While these teachers were interviewed in the context of their teaching in computing, they were also engineering teachers. Initially, I planned to focus on teachers who taught the computer science and information technology undergraduate programs. This choice was due to the motivation of not only using the findings for my research but also contributing to the improvement of the two study programs. In the end, I included other teachers in the department with similar teaching duties. Interviewees were of different genders and nationalities, where approximately half were Swedish and the other half were from other countries within and outside of Europe. Sensitive data was not collected for the interviews. Rather, as a co-worker, I had access

Paper	Data from	Data collection	Analysis
I	Computing teachers	Interviews, 5, Sweden	Phenomenography
II	Computing teachers	Interviews, 5, Sweden	Thematic content analysis
III	Computing teachers and students	-	Argumentation (empirical data used to illustrate points)
IV	-	-	Argumentation (no empirical data used).
V	Computing teachers	Survey, 199, Multinational	Thematic content analysis, descriptive statistics, group comparisons (Kruskal-Wallis)

Table 3.1. *Main information about each paper in terms of data*

to this information independently of my research, naturally and informally obtained without prompt during social interactions, such as citizenship being casually mentioned. I also checked the interviewees' institutional profiles, which included their current position and division/unit within the department. This can be seen as naturally occurring data [82]. The diversity of teaching experience, details on research area, etc. were part of the research-specific data [82], collected specifically for the study.

After each interviewee signed the consent form (see Appendix B), they answered a list of questions that mainly included inquiries about the concept of role model, how it affected the behavior of the teacher, and how other role models were or could be incorporated in the teaching. The complete set of questions can be found in Appendix A. All the interviews were conducted in English; all were conducted in person except for one online. The interviews were recorded and had an average length of 55 minutes. I took notes during the interviews, and I later used them to inform my analysis.

The main focus of the work has been on five of these interviews. After that, saturation was reached. I still conducted four more interviews (for a final total of nine) to consider more diverse perspectives (and as more training in data collection at the beginning of my Ph.D. studies). For the higher level of abstraction of role modeling that I wanted to explore, the main themes were found within the first five interviews and more quotes in the following interviews fitted these.

To understand why I refer to teachers here and not educators, I briefly describe the Swedish context. It differs from other contexts in other countries in several manners. Students who are Swedish or citizens of another in the European Union do not pay tuition fees, and a similar mobility privilege applies to faculty not needing a work permit or visa. The teaching staff is addressed

by name, and the hierarchy between staff and students is less noticeable than in other countries where some of the participants and I myself have studied or worked in academia. The main person in charge of a course has the title of course responsible, and they are, together with others, teachers. Teaching assistants (TAs) are those who are students (from undergraduate to Ph.D. level) and/or carry on tasks that support the work of the teachers, e.g., they assist in labs, give feedback on assignments, etc. In the Swedish context, the teacher refers then to all in the course with a higher level of power than teaching assistants. As the study involved teachers reflecting on their own role modeling, I interviewed those with more power, i.e., teachers and not educators (which would have included TAs). In contrast, in the multinational context of the survey described below, we aimed to have educators of all levels of experience.

3.1.2 Multinational survey

For Paper V, we designed and distributed a survey to explore how computing educators in higher education perceived their role modeling of types of care, emotions, and professional competencies (see Chapter 2). When the researcher is interested in something not observable, two common approaches for data collection are surveys and interviews. We chose a survey instead of interviews or other methods in order to maximize the number of educators whose thoughts on this topic we could learn from, as this was an exploratory study [38]. We aimed to reach as many educators (with varied lengths of teaching experience) across the globe as possible, and thus for distribution, we used mailing lists from professional groups such as ACM SIGCSE (the ACM Special Group on Computer Science Education)¹, our own institutional channels, and personal networks, the equivalent in social media, etc. We also asked recipients of the call to participation in the survey to further spread the call among their own networks. Thus, estimating how many educators were reached with this call was not feasible.

The survey started with Likert-scale questions that helped us validate whether the participant was in our target population, i.e., teaching duties in computing-related areas, the length of their teaching experience, and the kind of duties and interactions with students that they had. The next two Likert-scale questions inquired about the frequency with which educators thought they showed certain types of care and emotions to their students. Each of these questions had a following open-ended question where we asked for 1) examples of situations when these displays of emotions or care happened for those that were shown, and 2) reasons for not displaying the ones reported as not shown. The survey ended with questions about other displays of role modeling, including professional competencies, and freer prompts. The complete survey, including the consent form preceding it, can be found in the appendix of Paper V.

¹See more about SIGCSE at <https://www.sigcse.org/>

3.2 Analysis

Here I describe how the data analysis in Papers I, II and V were conducted. For Papers III and V a brief reference to the theory used is included. This theory was used with argumentation, where “conclusions are reached through arguments presented by the author(s).” [82, p. 7].

3.2.1 Paper I: phenomenographic analysis of teachers’ experiences as role models

In Paper I, I wanted to gain an understanding of role modeling from the particular perspective of computing teachers in higher education, of how they understood in different ways what being a role model for students could be. The research approach I used to understand computing teachers’ experiences as role models for their students was phenomenography. It encompasses more than the analysis phase of the work, as detailed below in this subsection.

Phenomenography [87] started in Sweden in the 1970s and it is based on the view of knowledge as subjective and relative: the external world affects, together with thinking, the creation of knowledge and conceptions. Phenomenography adds the perspective of how the individuals in the study experience the phenomenon. Marton and Booth [87] define this as the variation in ways of experiencing phenomena, where experience and comprehension are synonyms. The variation comes from what is in focus in the awareness of the experiencer, i.e., what can be distinguished from the rest. This means that one individual may focus on different aspects at different times. These different ways of experiencing a phenomenon represent both the collective understanding and variations within the same individual. They are presented as an outcome space: as logically connected categories, often in a hierarchical form (such as from least to most advanced level of understanding).

As Kinnunen and Simon state [64], phenomenography is especially suitable for studies where prior knowledge is very limited or does not exist. This is the case with how educators in computing experience role modeling.

Lunn and Ross [79, p. 2] synthesize the stages of phenomenography as follows:

- Planning: articulate purpose, select methodology.
- Data collection: Determine who, why, and how; identify subjects or participants and recruit; gather data.
- Analysis: Become familiar with the data; identify meaning; sort, group, and structure; establish the outcome space.
- Interpretation: Contextualize results.

These stages are presented in this chapter in different sections with similar headings, and parts of it in some other chapters, such as Section 1.3 for planning.

It is key that the data shows the variation of experiences within the sample group. Thus, I considered different criteria for the selection of participants in my work. Section 3.3 includes further details in the approach and considerations in this area.

In CER many studies using phenomenography have focused on the understanding and learning of students, such as student identity development [110, 111], and novice programming student's learning of concepts and practice [32]. The work in this thesis is from the educators' perspective, more in line with phenomenographic studies such as [63].

Interviews are a common data collection method in phenomenographic studies [64, 24]. From the nine interviews conducted, as explained in Section 3.1, I analyzed five for this paper. It resulted in an outcome space that is further detailed in Chapter 5.

Phenomenography shows the collective understanding based on the experience of different individuals, as presented in the outcome space and my aim for Paper I. Säljö claims that phenomenography is rather focused on how these individuals talk and reason about the phenomenon [127]. This aligns with my goal of moving towards a framework that focused on the discussion of the phenomenon, of how individuals describe and reflect on their role modeling, and that was based on how educators did this. This thinking led to Paper II.

3.2.2 Paper II: thematic coding analysis to develop a framework

Conducting the analysis described in Paper I allowed me to see themes in the data that I wanted to further explore. For this exploration, thematic content analysis was more appropriate than continuing with phenomenography. That is, phenomenography was initially used as a way to explore a topic where little is known (i.e. how teachers have different understandings of role modeling), as recommended by Kinnunen and Simon [64]; with that initial exploration done, I continued towards building a framework based on the analysis conducted in Paper I and the literature. This led to the writing of Paper II.

The aim with Paper II was to have a basis to discuss the “what”, the “who” and the “how” of role modeling from the role model's perspective, particularly when this is an educator. This is part of addressing questions such as:

- How can we conceptualize what can be modeled in computing and engineering education?
- Who are main actors in role modeling?
- How is role modeling perceived by the role models themselves and by others?

The resulting framework is described in Chapter 5. Here I describe how the different parts of the framework were developed.

In order to consider various definitions and understandings of role modeling, I 1) used literature on role modeling (mainly in STEM), professional

competencies, identity, history of computing, and ethics; and 2) revisited the data used in Paper I. The literature included work not only on how the concept of role model was defined but also on descriptions of initiatives of which role modeling was part. The definition used as a point of departure was Gibson's, where role models are "person(s) an individual perceives to be similar to some extent, and because of that similarity, the individual desires to emulate (or specifically avoid) aspects of that person's attributes or behaviors. Individuals attend to role models as possible exemplars of the professional skills and personal attributes needed to achieve desired goals." [42].

I conducted deductive/theoretical thematic content analysis based on how it is described by Braun and Clarke's [18]: I first 1) got familiar with the data, to 2) generate initial codes, that were gathered into 3) themes, which were consequently 4) reviewed and 5) defined, to then be 6) described in publications and presentations. This method was chosen because of its flexibility and its focus on pattern search in the data especially in topics that are under-researched. It was also an advantage that thematic coding analysis is recommended for early career researchers, requires less prior knowledge than other methods (such as discourse analysis or grounded theory), and is well-known [18]. This, in turn, widens the breadth of 1) researchers that can give feedback to a Ph.D. student when they are, for instance, attending a conference and, 2) individuals outside of academic contexts that are interested in the work.

The analysis was not a linear but rather a recursive process. The data were the same five interviews as used in Paper I. As I had transcribed the interviews manually and had taken notes during them (besides having conducted the previous phenomenographic analysis), the familiarization with the data started early. Codes and themes were discussed with my supervisors, especially their connection. The analysis was latent, as opposed to semantic: I aimed not only to describe but also to interpret underlying meanings and assumptions, considering the social contexts to which the participants (and I) belonged [18].

Preliminary themes came from different sources:

- The outcome space from Paper I was used as a starting point, e.g., considering awareness and control, which led to the part of the framework on "how" concerning awareness and intention, or the category connected to representing "flaws" leading to nuanced definitions of being a "bad" role model.
- Terms from Gibson's definition [42], i.e., "aspects", "attributes", "behaviors", "professional skills", "attributes", "goals".

The data that did not fit these preliminary themes was then categorized separately as new themes. Some of these new themes were mixed with the preliminary themes for a final theme, e.g., professional skills (from Gibson's definition [42]) was combined with knowledge (not in the preliminary themes described above) for the final theme competency. Motivation for this grouping came from literature on professional competencies, such as Raj et al.'s [115]. Other themes were kept and reinforced by literature, e.g., attributes (from Gib-

son's definition [42]) was changed to character attributes, to better connect to the concept of virtue in virtue ethics (see Chapter 2). Yet other themes were renamed for a better fit of the framework's perspective, e.g., goals (from Gibson's definition [42]) was changed to achievements to show the role model's perspective (representing something already achieved) rather than the emulator's (looking for something they want to eventually achieve).

Other literature influenced the development of the framework. The identity and history of computing theory described in Paper III led to the *who* part of the framework regarding considerations of who is "in" or "out" of the discipline. It was also used to support the development of the more nuanced definitions of being a "bad" role model. Our work in Paper III shows the need for a vocabulary connected to modeling something that is not imitated. For instance, we refer to Peters's work [110, 111] where one teacher was not necessarily someone who would lead the student to a detrimental outcome if emulated but rather someone who was simply not emulated (in the framework, an inadequate role model, as detailed in Chapter 5). Similar considerations contributed to the themes of subjective and objective achievements in the *what* part of the framework.

3.2.3 Paper III: argumentation of identity and history of computing

In this paper, we addressed questions on how social contexts and cultures affect role modeling of disciplinary and professional identities in computing education. We used argumentation [83] and research in identity, role modeling, and the history of computing. The analysis informed in turn the analysis in Paper II, as described above. Data were not analyzed for this paper. Rather, we used quotes from previous studies to illustrate some of the points made in the paper. Data came from two sources: 1) the set of interviews with teachers described in Section 3.1, and 2) the data collected for Anne-Kathrin Peters's Ph.D. thesis from the student perspective [110, 111].

Our work with theory and argumentation started when two authors (Anne-Kathrin Peters and myself) discussed the connection between role modeling and disciplinary identities. I had read Peters's thesis on students' identity development in computing. This included quotes on how teachers in computing-related bachelor programs were perceived by the students. I then argued that part of that perception was connected to how the teacher *role modeled* an identity that was deemed as (un)desirable to the observing student(s). In other words, that Peters's examples were connected to teachers role modeling their students' goals of recognition: if the student wants to be recognized by others as a computer scientist (this is their goal), then they may look for (positive) role models that represent legitimate identities and avoid becoming the (negative) role models embodying identities that are not perceived as legitimate. What is

desirable and/or legitimate, and what is not, is influenced by what a community has socially constructed as unwritten rules or norms. We then shared the results of our argumentation at that point with two academics: Matti Tedre, who we knew could bring in deep knowledge on the traditions in computing and how this affects identities seen as (un)desirable, and Mats Daniels, who could connect this to professional competencies and how dispositions in particular were often considered not a part of computing (especially depending on who role models them). For more details on the theory used for this paper, the reader may consult the summary in Chapter 2 on identity and role modeling, and Section 1.2 for references on the history of computing traditions.

We developed this argumentation and the connection between the different kinds of literature throughout several meetings and discussions. In parallel, Peters and I extracted a few quotes from our studies to illustrate certain points. Once we divided the writing workload, we had more discussions and refinement of arguments were made when reading and trying to understand each other's nuanced reasoning, until we reached the final version.

3.2.4 Paper IV: argumentation of ethical theories and role modeling

In this paper, we focused on what can be role modeled as a teacher from the perspective of the “why” and “how”: If I, as a teacher, may be emulated, how should I behave? Why should I (not) model something? The answer depends on the ethical lens used to guide our reasoning. We used argumentation [83] and theory in role modeling and ethics. Data was not used in this paper.

This paper is a follow-up to work I wrote with one of the authors, Kristina von Hausswolff. In the original paper [51] we had started developing the idea of using virtue ethics and Biesta's purposes of education to connect with role modeling literature. Wanting to expand of theories ethics that could be used in this way, we invited Thomas Lennerfors to work with us as an ethics in engineering expert and Anne-Kathrin Peters as an advocate for care ethics in computing. The analysis process was similar as to that described in Paper III, with scheduled meetings for discussion before and during the writing process, and with authors commenting on each other's text, which led to occasionally refining our individual sections.

The main decision for the analysis was what theories to use within the different families of ethical theories. We decided on three ethical theories, i.e., virtue ethics, care ethics and ethics of freedom, because of their focus on the person. We then discussed how each of them connects to positive role modeling as a teacher, e.g., teachers embodying virtues, teachers caring for someone or something, teachers being their unique selves, and the equivalent for negative role modeling. For more details on the theory used, the reader may consult the summary in Chapter 2 on virtue ethics, care ethics, socialization and sub-

jectification, and role modeling. We also reflected on whether these aspects are reflected in the framework described in Paper II.

We did not intend to integrate these theories and present a silver bullet for role modeling as a teacher. Rather, our aim was to present how using each of them as a lens to explore role modeling as a teacher in engineering throws light on different aspects of the phenomenon. Tensions when applying one theory and with the other theories inevitably arise and can be addressed in different ways depending on the concrete circumstances of the person, e.g., caring for students may come at the expense of caring for oneself, and each individual teacher can judge how to adjust for this imbalance considering their personal situation. This is an example of the implications for teachers as part of Chapter 6, describing different reflections that we recommend as a result of our analysis.

3.2.5 Paper V: thematic coding analysis, descriptive statistics, and group comparisons

In this paper, we looked at what can be role modeled in terms of types of care, emotions, professional competencies, and other kinds of role modeling that educators in computing may display, in which situations they do (or do not) show these and reasons for (not) doing so. The multinational survey described in Section 3.1 was the source of data for this paper. To develop it we made use of theory in role modeling, care, emotions, and professional competencies (which are all described in Chapter 2). The framework described in Paper II was also used to frame our work and look at our data.

We conducted qualitative analysis and quantitative analysis. In the discussion section of the paper, we connect these different findings. This approach is especially interesting for emotions. Self-reporting of emotions is the most common approach to doing research on emotions in engineering education [81], and quantitative methods are commonly used for it. In Paper V we add a qualitative approach, which is seen as needed in this research area [80]. Paper V, given the opportunity of lack of a page limit, contains a detailed description of how the analysis was conducted, so I summarize some points here.

The quantitative analysis consisted of descriptive statistics and group comparisons. In particular, the group comparisons for different levels of teaching experience were done through Kruskal-Wallis tests, the non-parametric alternative to ANOVA tests, for dimensions of care and emotions. Some dimensions were grouped for further analysis, e.g., the five dimensions of care were divided between care connected to living agents (i.e., self, others, other living, planet) and non-living (i.e., technology).

The qualitative analysis was thematic content analysis based on Braun and Clarke's [18]. As opposed to the analysis in Paper II (which included rich interview data), this time we chose a semantic approach [18], as our data con-

sisted of short sentences (or even single words) more suitable for description focus than for an analysis of underlying ideas and assumptions. I was the only researcher who accessed the raw data and I read all of the responses (200, one invalid) several times, checking for any unprompted mentions of sensitive data that needed to be removed before sharing the data with the rest of the team. I thus became familiar with the data early and had an overview that helped us decide the final division of labor for the analysis: one team of two researchers would focus on the responses to the questions connected to care, one of three researchers on emotions, and another three researchers on professional competencies and other role modeling. Each of these sub-teams was led according to our expertise by one of the ITiCSE Working Group leaders of which Paper V is a result: Anne-Kathrin Peters led the analysis focused on care, Päivi Kinnunen the analysis on emotions, and I led the professional competencies and other role modeling group. This way, we could coordinate both in leader meetings and in general group meetings, to different levels of detail. As detailed in the paper, sub-teams shared partial findings and adjusted their analysis based on what was being learned from other sub-teams. We would also flag data found in responses analyzed by one sub-team that could be connected to a different sub-team's focus, e.g., we marked responses connected to care that this sub-team considered in their analysis. While the analysis of care and emotions was inductive, for professional competencies it was deductive, making use of the framework for professional competencies in Raj et al.'s [115] and the framework in Paper II for other kinds of role modeling as well. Besides the coordination meetings, we made use of online tools to be able to easily consult each other's analyses in detail when needed.

3.3 Ethical considerations

In this section, I include the main ethical considerations that I made related to the topic, participants, other researchers working with me, myself in the role of a researcher, and the broader context.

One of the lenses I use here is care ethics (see Chapter 2), i.e., I consider my relationship with others (and myself), identifying and attempting to address their needs (mine included). I have also made considerations highlighted by Robson and McCartan [123], as marked in the text in this section, encompassing what I have learned in my research ethics training. After reflection on and in accordance with my own values and beliefs, I have followed the codes of ethics from several major professional associations in computing and engineering, such as ACM [35], IEEE [59], and BCS (British Computer Society) [137]. Overall, I have followed the Swedish Act (2003:460) concerning the ethical review of research involving humans [121] and the principles outlined in The European Code of Conduct for Research Integrity [2] by The All European Academies (ALLEA), which are also part of the recommendations by

the Swedish Research Council [26]. These principles, as presented in [27], are:

- Reliability in safeguarding the quality of the research, which is reflected in the design, method, analysis and use of resources.
- Honesty in developing, implementing and scrutinising research, and in reporting and informing others about research in an open, fair, complete and objective way.
- Respect for colleagues, research participants, society, ecosystems, cultural heritage and the environment.
- Accountability for research from idea to publication, for management and organisation, for education, supervision and mentorship, and for their wider consequences.

As reflections more focused on how I as a researcher affect my work, in Chapter 4 I have written a positionality statement.

3.3.1 Selecting topic

Ethical considerations come into play already when choosing a research topic [123]. I have chosen role modeling because I am aware that, in their current form, spaces around and within computing and engineering education are not for all. Role models can be an approach to address this issue; while they can be particularly beneficial for those from marginalized groups (see Chapter 2), it is a phenomenon that concerns all students and educators. Others in education also have the power to effect positive change. In a sense, this project is about raising awareness of the role we *all* have in who feels welcome and as like they belong in our disciplines, in what ways one can be recognized as part of our communities (both in education and in research environments). It is about humanizing computing and engineering education by encouraging role modeling of aspects and achievements connected to care, emotions, and dispositions that are lacking representation in these disciplines [115, 36, 122, 101]. Caring for students, educators and other professionals close (or not) to me, I chose to aim to contribute to scaffolding our reflections as and discussions on role models. For my personal connection to this topic, see Chapter 4 for my positionality statement.

3.3.2 Considerations related to participants

When selecting interview participants, I aimed for a diverse representation of voices that are amplified by my research. This is in line with points in the codes of ethics mentioned above, such as “Be fair and take action not to discriminate” [35] and “respect and value alternative viewpoints” [59]. However, there are other considerations to make to achieve this goal, of which I emphasize two here with the example of gender. The first one is the potential clash

with another principle: “Honor confidentiality” [35]. For the interviews I conducted, with so very few women teachers (and no non-binary/gender-diverse people that I knew of at the moment of data collection), it was not possible to highlight gender while keeping confidentiality, e.g., if I quoted a woman teacher in the study program, it would not be too hard for other colleagues to guess who this person was based on further details in the data. Secondly, I also considered the ethical implications of asking teachers from historically marginalized groups who may already be overloaded precisely because of how their identity(ies) can be perceived, e.g., women being asked too often to serve in committees to achieve gender balance in these groups. My approach to mitigate both issues was to expand the study from two specific study programs to all the teaching at the department.

Participation in the interviews was voluntary and could be withdrawn at any point. For details on the consent form given to participants before the interview, see Appendix B. Although there are arguments for including participants who do not volunteer, e.g., to reduce selection bias [123], in this case, mandatory participation is both illegal in Sweden² and ethically questionable. I had the ethical responsibility to inform relevant individuals in the department, such as degree program coordinators, of my findings so that the study programs may be improved. Thus, I did not want participants to become concerned about their participation (for instance, by being critical of some aspects of their job) affecting their employment in any way. The teachers invited to interviews were informed by email before their interviews about how the findings would be used. This aimed to give them time to consider their voluntary participation and the opportunity to ask questions (about this or anything else related to the project) to the researcher (me) before participating in the study. Rather than imposing one, I also asked the participants for their chosen interview venue so they were as comfortable as possible.

I applied commonly used techniques to preserve anonymity in the interview transcripts and the excerpts used when disseminating findings. For similar reasons, I assigned pseudonyms to each participant that reflect whether they are Swedish and their legal gender. When it was brought up that someone else in the department had as a real name one of the pseudonyms I had used in a publication, I changed it in following publications to avoid misunderstandings. Some of the other pseudonyms are common names in Sweden and our department has a large number of employees. So it is unavoidable that, at some point, someone is working in the department with that name.

Different ways of including the interviewees in the process were used. I consulted interviewees to check whether they agreed with how some of their quotes were interpreted. Interviewees were invited to seminars connected to this work when appropriate and when it would not jeopardize their anonymity.

²See Article 27 in the Swedish Act (2003:460) concerning the ethical review of research involving humans [121].

When Paper I was published, it was distributed among the interviewees. My work has been presented several times at the department where the participants had access to the work conducted after Paper I was published.

The survey did not ask for names, affiliations, or information on demographics. Only I could access the raw data from a team of researchers looking at the survey data. I reviewed all the responses several times before sharing the data with the rest of our team to ensure no sensitive information was included. The only information that identified participants was the email address they could voluntarily leave at the end of the survey to be contacted for future work. Only I had access to these addresses, which were provided by 54 out of 200 survey participants. Paper V includes the consent information given to participants and the survey questions. This included information on the benefits and risks of participation, how the data would be handled, etc.

As participation in the survey was anonymous, we could only contact the participants who voluntarily left their email addresses. We did so to thank them for their offer, informing them of plans and attaching Paper V (open access) for their information.

Conducting low-quality work is harmful to the participants [123]. A researcher should “NOT claim any level of competence that [they do] not possess” [137] and should “develop [their] professional knowledge, skills and competence on a continuing basis” [137]. I addressed this in different ways: there were opportunities to ask questions to the researcher (before, during, and after participation in the studies), I received education on research ethics during my Ph.D. studies, I have been supervised (by various academics who specialized in different topics and participated in different research communities), and made use of my previous experience. I also invited other researchers with areas of expertise and perspectives different from mine to work with me, which I believe very positively affected the quality of the work. In Chapter 3.4, this and other aspects of the trustworthiness of my thesis work are further detailed.

3.3.3 Considerations related to co-authors

As the first author of all the publications in this thesis, I had a leading role in all the work. This gave me both some power and the ethical responsibility to do my best for the well-being of my co-authors in the context of our work together, to co-create with them a work environment where their interests and expertise could be appreciated, developed, and expanded.

Ongoing research on educators’ mental health (see, e.g., [130, 131, 95, 132]) shows how academia is an environment where it can be challenging to maintain one’s well-being. Being an academic in DBER can lead to habits that negatively impact the lives of these academics, e.g., Carolina de Barros Vidor’s Ph.D. thesis [148] shows examples of how academics may be pressured to

work long hours, neglect their eating habits, etc. as the only way to keep up with the pace, expectations, and pressures of their academic context. While it can be argued that a paper should be “as good as possible” for it to have “the most” positive impact on the world and society, this should never come at the cost of personal health, of damaging the potential of future collaboration or of perpetuating harmful practices in research.

My primary approach to these responsibilities was care ethics (see Chapter 2 for details). I had meetings and other conversations with my co-authors so that we could together identify their needs and ways to meet them. That is, besides assumed needs connected to our knowledge of how CER and EER academia works and what it demands, we engaged in dialogues that allowed us both to refine assumed needs for the particular case of the cared-for’s circumstances (e.g., university requirements for publications) and to identify expressed needs as well. This included discussions on what kind of work each person was interested in, which tasks would help the team while making use of and/or developing that person’s competencies, individual levels of ambition and availability, etc. In particular, I aimed to offer many opportunities and channels to communicate when one of us could not complete work in the previously agreed timeline and how that work could be redistributed. While private details were never asked about, they were frequently shared, such as those related to caring responsibilities (of children, relatives, one’s own well-being, etc.). Once shared, the team would do their best to support that person (or I would, if shared only privately with me). Different communication alternatives were available to confirm whether the needs of the cared-for had been met.

Regarding the use of this approach when working with other researchers, I am particularly proud of our team for Paper V. As we worked together for approximately nine months at various levels of intensity, there were plenty of opportunities to have a caring approach to work. We decided to start each team meeting with a round where each of us would share how we were feeling. I find this important for all work, particularly for discussions on role modeling and systemic barriers that prevent it and for potential answers to the survey where our marginalized identities could be dismissed. While we are trained to analyze data, we are also people that should be allowed to experience all kinds of emotions while working, such as hopelessness when findings lead us to believe that not enough is being done to address the climate crisis. Our round on our current thoughts and emotions included sharing not only obstacles and so-called negative emotions but also pleasant experiences and news. We could then continue the meeting considering this information, which was used to, for instance, re-plan some tasks. Outside of meetings, I aimed to include in our emails a compilation of the successes (at all levels) that I was aware of team members achieving, e.g., paper publication, official recognition by a community, etc. To keep everyone’s privacy, I only shared what I could see in public spaces, such as social media. To avoid that team members would spend too

much time or energy on the project, we encouraged each other to take breaks, which was especially important at times when our well-being was at risk, such as when we were very close to deadlines.

3.3.4 Considerations related to me in the role of researcher

Considering the risks for the researcher [123], in my case, they were mainly related to 1) the possibility of comments from participants (live in an interview or by writing in the survey responses) that negatively affected me, and 2) my well-being overall.

As someone with several marginalized identities and relatively new to the academic world (see Chapter 4), there was a risk of participants providing patronizing, sexist, transphobic, etc. input. While this risk was low in general (higher in the survey due to anonymous participation), and I am trained to deal with these issues, in considerations to co-authors above I have already included the main ways this risk was approached. Again, I emphasize the importance of making room for the emotions triggered by these situations, despite the training, and considering that said training might not include well-being practices adapted to the needs of all academics, or it may not be enough for those dealing with various types of mental illness.

As described for academics in general, the mental health of (graduate) students is also receiving attention in research in engineering education (for a review, see [16]). In terms of my well-being (see positionality statement in Chapter 4), I aimed to have a healthy balance of caring for myself, my family (especially my small children), and my colleagues. I also spent time discussing expectations in academia for different career stages. I (with the privilege it shows) observed and/or talked to individuals who modeled different ways of coping with workload and pressure and attempted to incorporate the ones that fit my circumstances into my practice. When working with others, I would choose between different levels of information disclosure about my current well-being, e.g., I could be very transparent about feeling too overwhelmed if I felt this would help the other person and myself in our caring relationship, I may refrain from details if I felt that the information would burden the other person, or I may not share this information at all depending on the circumstances. Overall, I tried to express both my needs (so that others could help me meet them) and my confirmation of these having been met (so that others could understand that their care had been received). While this may read as a focus on helping others, it is rather on caring for myself through supporting others in caring for me.

3.3.5 Considerations related to the broader context

Considerations connected to the context of my work outside the ones described above have evolved throughout my Ph.D. studies. From the start, my aim was for my work to reach not only academics but also practitioners. To this end, I presented as often as possible, not only in CER and EER events but also in other contexts, such as pedagogical conferences, workshops with new educators, and events celebrating women in computing and for networking of engineers as refugees coming to Sweden. The feedback received helped me in turn to refine my work and how to approach various audiences. To contribute to the dissemination of other research, I have organized events with free and virtual entrance, e.g., one (online) on role modeling in computing education in November 2017 and one (hybrid) on the humanization of computing and engineering education in June 2023.

For accessibility, as publications can be behind a paywall, I also used other formats to disseminate my research, such as videos and slide decks publicly available. Later in my Ph.D., it became feasible to publish open access thanks to agreements between Uppsala University and publishers, as is the case for Papers IV and V.

It was mainly through the role modeling of one of my supervisors, Anne-Kathrin Peters, that I became increasingly aware of academics' role in addressing the current climate crisis. Since then, I have decreased the number of events that require flights, among other actions. Attending conferences virtually, such as RESPECT, has been an option I have greatly appreciated not only for environmental reasons but also for family ones: I could attend presentations and then take care of my children. I hope that hybrid events continue for the increased accessibility they provide.

In a previous draft of this thesis, it was brought to my attention that some of the content in my text could potentially be interpreted in a way so that Article 3 of the Swedish Act (2003:460) concerning the ethical review of research involving humans [121] applied. If I, my identities, and my choices, as described in the ethical considerations (this section) and positionality statement (Chapter 4), were to be considered part of my research, then I and the text describing me had to comply with said Swedish Act [121], i.e., ethical approval was required for me to include any sensitive personal information (in this case, about myself). Thus, I should not disclose, for instance, my sexuality or anything that could be interpreted as a health diagnosis. By keeping this in the text, without time to receive ethical approval, I would be risking an outcome where I would not be able to publish my thesis and possible legal consequences would also extend to my main supervisor and the university. While I considered that including this information was important and I was told that the risk was low (as this was a very strict interpretation of the law), I decided I was not in a professional or personal situation to be able to take that risk.

As I have presented that positionality statements are still relatively new in CER and EER (see Chapter 4), and the discipline of CER itself is rather young (see Chapter 1), there is still work to do to establish practices that ensure that ethical considerations and positionality statements cannot be interpreted as unnecessarily colliding with legislation.

3.4 Trustworthiness

In this section, I describe the considerations I made regarding trustworthiness. For this, I use two sets of concepts: 1) I follow Collier-Reed, Ingerman, and Berglund's view on trustworthiness in phenomenography [24], as this was the research approach for Paper I, and 2) for the rest of the work in this thesis I rely on the seminal work of Guba and Lincoln [52]. Although the headings refer to interviews and data, I reflect on trustworthiness in terms not only of data collection but also of other stages of the research process. All the publications connected in this thesis have been peer-reviewed.

3.4.1 Interviews

I analyzed the interviews using two different approaches. I used a phenomenographic approach in Paper I. In Paper II, I used thematic coding analysis.

Phenomenography

When presenting trustworthiness as it relates to the phenomenographic process of producing an outcome space, Collier-Reed, Ingerman, and Berglund [24] explain the concepts of credibility and dependability by adapting Guba and Lincoln's work [52]. Ensuring credibility is important for others to have a believable understanding of the research process, while dependability matters for consistency in interpretation and findings. Each term can be further explained by referring to different categories within it.

Content-related credibility refers to the researcher's knowledge of the phenomenon being studied. It is important not only that the researcher is informed but also that they have an open mind when conducting the research. This is because they will be studying the study participants' collective understanding of the phenomenon, which may differ from the definitions and understandings in academic circles [24]. Before designing the project that included the interviews, I had familiarized myself not only with the literature on role modeling but also with several popular definitions of the term. As this showed me that there is no clear consensus on a nuanced definition of role modeling, I was ready for various experiences of it as expressed by the interviewed teachers.

Credibility of method includes the selection of participants, the context, structure, and content for the interviews, and the analysis [24]. In Section 3.1, I have detailed how I aimed to select a diverse sample of teachers and

I describe the context for my work, including reflections on potential power dynamics connected to the interviews that are also considered in Chapter 4. In Appendix A, it is possible for interested readers to check the structure and content of the interviews.

Communicative credibility relates to how others may perceive the work as legitimate. Externally, this is done when presenting research findings at conferences or other contexts. Internally, this would refer to how the participants see the findings and conclusions [24]. As Paper I is a peer-reviewed conference paper, and I conducted the work partly as assignments in courses as part of a research school, there have been many presentations of the outcome space, conclusions, etc. not only after publication but also while developing the work. It is contradictory to ask individual participants to scrutinize the collective understanding represented by the outcome space; the participant's experience is only a part of it [24]. However, as explained in Section 3.3, I still provided the participants with different ways to learn about the work and discuss their thoughts with me.

Dependability as a function of the interview conversation refers to how the researcher needs to work on allowing the participants to express how the participants themselves experience the phenomenon. For this, it is essential to avoid leading interview questions both within the questions prepared as part of the semi-structured interview and within the follow-up questions that may need to be formulated "live" during the interview. [24]. I pilot-tested the interview with a teacher, editing the questions that were ambiguous or led to discussing topics other than the ones connected to my research questions. I also discussed the interview guide with my supervisors and received training in interview techniques as part of my Ph.D. courses.

Dependability as a function of accuracy of transcription refers to how the interviews are transcribed, as this is part of interpreting the data [24]. I manually transcribed all the interviews. Phenomenographic analysis does not require a transcript with as much detail as that for discourse analysis [24]. I did include pauses (short and long) and laughter in the transcript. I also revised the transcription by checking the text while re-listening to the recorded audio.

Dependability as a factor of analysis can be ensured through intersubjective agreement, where researchers discuss their views on the data analysis. I discussed my work with my supervisors and other colleagues at various stages of the analysis. This led to modifying the categories and structure of the outcome space several times.

Thematic coding analysis

There are different approaches to addressing a research project's credibility, transferability, dependability, and confirmability. Here I describe how I did so in connection to the interviews (except for in Paper I), as summarized by Guba and Lincoln [52].

For credibility, some approaches are 1) prolonged engagement at the site, 2) persistent observation, 3) peer debriefing, 4) triangulation, and 5) member checks [52].

There was prolonged engagement and persistent observation as part of my study and work experience. As I had been a student at the department and then a staff member (including teaching duties) for two years before starting my Ph.D., I was familiar with the context from several perspectives when conducting and analyzing the interviews. This presented advantages, such as more honest and/or personal contributions during the interviews. I considered whether having met me before, or at least knowing who I was, might have also increased the interviewee's potential wish to please me as the interviewer. This may have been the case when accepting the interview invitation, or perhaps because those who have acquired a Ph.D. can relate to being a Ph.D. student and want to help. In Section 3.3, I address voluntary participation. I did not see signs of trying to please the interviewer in the interview data. I also considered whether the difference in experience, the power imbalance, might have made interviewees more reluctant to share their shortcomings with me. Perhaps this happened to some extent, but the findings show how the teachers mentioned so-called flaws. In some cases, having the interview in English was a way to accommodate me and my work, as perhaps in a different context some interviewees would have used Swedish instead; and yet, with other interviewees, we shared our discomfort (to various levels) with speaking a language other than our mother tongue.

As for peer debriefing, as explained above and partly in Chapter 4 and Section 3.3, I have often discussed my work before, during, and after it was carried out or published. These discussions have been with colleagues with different lengths of experience, from different research areas, of various social identities, and the equivalent with individuals who are educators in STEM areas or higher education in general. All papers in the thesis have been peer-reviewed.

The data I use in this thesis is focused on the educator's perspective and, as such, is self-reported by the participants. One of the aims of the framework presented in this thesis is precisely to support educators working on getting a more concrete idea of the kinds of role modeling that they think they do for their students. As described in Paper V, as a form of triangulation, the survey data could be analyzed with the framework developed with theory and interview data, both data sets offering different perspectives for the same phenomenon of role modeling as an educator.

In Section 3.3, I describe member checks in more detail. As described for the phenomenographic analysis, the interview was pilot tested with a teacher before starting the study with the selected interviewees. This helped refine the questions and consider different interpretations of them, besides adding possible follow-up inquiries.

For transferability (for the work to be repeated somewhere or some time else), the researcher can think about 1) theoretical/purposive sampling and 2)

thick description [52]. In Section 3.1, I have detailed how I aimed to select a diverse sample of teachers for the interviews. In this thesis, I have provided detailed descriptions of all stages of the research process, from my aims, to how data collection and analysis were conducted. This includes quotes in the thesis that are less shortened to keep a good level of detail. The description of my research process is supported by Appendix A and Appendix B. While it can be used to some extent for other contexts that include individuals outside of a classroom setting (see Chapter 6), the framework is developed using literature and data focused on and representing the experiences of educators as role models and students as emulators. It may have been that, had I conducted interviews in another country, culture, and barriers related to citizenship or hierarchy may have been more prominently mentioned. However, as the framework's abstraction level is relatively high, I believe that it would have still worked.

Dependability can be ensured by ensuring, in turn, credibility. Even though I have done so above, I include here that an approach is to have a dependability audit, where an external party will analyze methodological choices and other steps of the research process. As four different academics have supervised me, besides all the discussions with others mentioned above, this dependability audit took place several times by different individuals.

Confirmability in qualitative research focuses on the data. It is possible to use 1) triangulation (as described above), 2) reflexivity, and 3) a confirmability audit. Chapter 4 contains a detailed description of my practice of reflexivity, and I have explained how others conducted audits (in this case, by checking that the findings made sense, connecting to the raw data and the methods used).

3.4.2 Survey

The survey was the instrument for data collection for the exploratory study presented in Paper V as our work in an ITiCSE Working Group [88]. We did not aim for generability of our findings nor did we want to test hypotheses. Rather, this study served its purpose of revealing educators' perspectives and experiences on care, emotions, and professional competencies, which added to and complemented the findings from my prior qualitative work using data in the Swedish context, and suggests different possibilities for future work.

Our team comprised academics at different career stages, located in different countries, and with different backgrounds (see the positionality statement in Paper V for details on the team members and Chapter 4 for my case). This brought a range of various experiences to all stages of our work, from designing the study and the survey to analyzing and discussing the findings.

We distributed the call of participation through common mailing lists used in CER, such as one for members of SIGCSE and other channels, such as social media. In terms of participant selection, there is a risk of bias due to

the call for participation being distributed also among our networks, and that participation was voluntary. As for whether the participants might have tried to please the researchers, this risk may have been reduced by the facilitation of anonymity in the survey.

The context of an ITiCSE Working Group [88] involves having a limited period to obtain ethical approval for sensitive data. As we did not deem this process feasible under these circumstances, instead we did not ask for this information in the survey. Considering sample representativeness, this means that we cannot present data about demographics to know to what degree the data is representative. As some participants voluntarily left their email addresses, which only I had access to, I know that several institutions in different places were represented. But we do not know, for instance, the list of countries for all the participants, as this was not part of the data collection. However, as stated above, generability of the findings was not our goal.

The data we collected with the survey was self-reported. For self-reporting of emotions in particular, Pekrun states that for “a nuanced picture of emotions, self-report is indispensable” [105, p. 1810]. There are disadvantages with this approach, such as issues with memory bias or the unfeasibility of capturing emotions in real-time [105]. Despite these disadvantages, self-reporting is the most common approach when doing research on emotions in engineering education [81]. As stated above, it makes sense to use this approach when studying the perspective of the educators themselves and is in line with surveys being used to investigate that which is not observable [38].

It was by making use of all our different experiences and areas of expertise (with team members having research experience in care, emotions, professional competencies, role modeling, and other topics) that we designed the survey together in several rounds, revising particularly that the questions fitted our aims. We also incorporated the input from pilot testing it with seven educators with different backgrounds located in various countries. The final questions and information provided to participants for their informed consent can be found in the appendix in Paper V.

As described in Section 3.2, during the analysis there were frequent discussions within and between sub-teams of researchers. Thus, the work of each sub-team was informed by and influenced the work of the others.

4. Positionality Statement

I believe that who I currently am, my background and other aspects of myself influence my research, from the moment I decide on my research topic to closing the research project. Thus, in this chapter, I write a positionality statement, after motivating why I do so. Garcia describes positionality in this way:

Positionality is a critical understanding of the role a scholar's background and current (socially constructed and perceived) position in the world plays in the production of academic knowledge [...]. [It] highlights that the way an academician is situated in space and time fosters a specific understanding of social reality. Positionality provides a space to critically interrogate the researcher's motivations, assumptions, and decisions at each and every stage of the research process. [39, p. 568]

In engineering education research, positionality statements (in the less common instances of publications where they are included) are approached in three different ways depending on what is disclosed: identities, experience and opportunities, and journeys [56]. In this chapter, I have aimed to cover all of these approaches. Initially, there is a strong focus on identities as a reflection of how I see their strong influence on my experience, opportunities, and journey. I then end the chapter with a reflection in the opposite direction: from reflecting on how my position influenced my research and others, to considering how my research affected me and others.

4.1 Why and how is a positionality statement included in this thesis?

Positionality statements have been a practice established in social sciences [58] but not yet as much (or at least as thoroughly) in EER [136] and CER, e.g., few papers in CER describe their epistemology [83]. Perhaps the limited space in conference publications (usually 8-12 pages, including references) is one factor for the absence of positionality statements. Positionality statements provide more transparency to readers, showing how the researcher(s)' identities, experiences, beliefs, and values affect what they study, how they conduct research, and who is affected (such as study participants) and how. This includes the role of power. It can be argued that failing to include such statements or to use reflexivity, can be seen as unethical [58] and as a threat to the credibility of the findings [56].

In this chapter, I reflect on my positionality by intertwining my answers to the reflection prompts for each dimension of positionality, as defined by Secules et al. [136, p. 7]:

- Research questions: How does your positionality impact what research you choose to do?
- Epistemology: How does your positionality impact how you know what you know?
- Ontology: How does your positionality impact what you can observe as a researcher?
- Methodology: How does your positionality impact your methodological choices?
- Researcher-as-instrument: How does your positionality impact how you relate to research participants?
- Communication: How does your positionality impact how you represent yourself in writing and other communication?

4.2 Positioning myself

Before writing this statement, I want to acknowledge that feeling relatively comfortable disclosing such personal information in itself shows privilege, where privilege can be defined as “systemic, unearned advantages that accrue to individuals because they belong to certain groups.” [11, p. 161]. I can make this information public¹ with no serious repercussions (such as barriers when I am in the job market) for myself, or at least without the added barriers and repercussions that others without this privilege encounter. For instance, a significant part of my privilege comes from identifying and being perceived as white. I have been teaching in classrooms where I frequently was the only white person and the one with more power. My privilege also comes from my (extended) family’s socioeconomic status removing important economical worries for me, and from having two parents with degrees in higher education.

Writing this statement can be both a soothing and terrifying experience that takes considerable time and emotional labor. It requires a lot of vulnerability [56, 136]. I am inspired by others who dared before me to be this vulnerable, e.g., [136, 53]. So I approached this writing in several rounds and used well-being practices and different kinds of support available to me. Time is an important factor from another perspective, too. Naturally, positionality flows and changes throughout time, especially in a project as long as a Ph.D. thesis [58]. Thus, with this statement, I aim to reflect on those changes and highlight that here I present what can be seen as the current snapshot of my positionality, which differs from the ones for other past and future projects.

¹I would half-jokingly add “publicly to some extent”, as I am often reminded by many that “nobody reads Ph.D. theses”, which seriously makes me think that the risk is then lowered.

4.2.1 Social identities

I am a non-binary person, who used to present and almost always is still perceived and addressed as a woman. My gender identity (whether as I see it or as perceived by some) has always involved being part of a minority among the majority of my male peers in computing. It has played a role in my experiences of navigating difficult situations as a student and later as a teaching staff. I was trying to understand unwritten but supposedly widely-known rules, created with people not like me in mind. My male friends and colleagues were not addressed similarly; their actions were met differently. For instance, I could be perceived as less competent than my male colleagues, which is unfortunately not uncommon in education; see, e.g., [90]. Thus, though in theory I was surrounded by potential role models, in practice, I often could not make much use of the examples I saw embodied by others around me, as imitating them would have different consequences for me than what I saw meant in their case. Since I still needed to learn, and there was no official rule book to deal with micro-aggressions and other issues, I wondered if I could learn from others like me (thinking that, perhaps, role modeling would then be more effective). As this kind of learning by observing similar others was usually not possible within my network, for lack of people that I perceived as like me, such as those using the same pronouns (they/them), I expanded my search outside of my usual circles, particularly online.

Finding people like ourselves proves more difficult when our identity is hidden, i.e., over-simplistically, an identity that is considered as not readable by appearance, as opposed to an apparent identity [136]. Even more so when being open about our identity may not always be safe for us in different contexts. I was reluctant to share my non-binary identity without more clues on how it would be received; I could not know if someone was non-binary unless they chose to disclose that to me or somehow publicly. While the examples of queer people I could find online sometimes helped, other times I saw them as representing a culture that did not match my experience; this made me feel like I was not “queer enough”. So I had a personal reason to be interested in role models from different perspectives. Interested in how role models do not always have positive effects on us (which does not necessarily mean they represent something negative), like my role models had affected both positively and negatively my sense of belonging to different communities. Interested in the impossibility of one person embodying all the ways of being and doing that we connect to a certain label. Interested in how and why we feel that we can disclose (or not) parts of who we are that can be very important to observe by others like us.

As an early career academic, during my Ph.D. studies, I have often been in situations where a lack of confidence (partly, from lack of experience) and levels of uncertainty made me feel overwhelmed. As a reaction to this, I tried to have as much control over as many things as possible. Once I had a more stable

job, I started being very open about both this and my queerness, which led to people who shared some of these experiences contacting me. And every time a student or someone else has noted that and asked for advice and/or expressed that they look up to me, my (hidden) reaction has been worry and uneasiness (“What if I don’t match their expectations?”). Perhaps my Ph.D. work was an attempt to deal with part of these feelings as an educator and support others in similar situations. I believe this focus on needing both scaffolded reflection (rather than significant worry) and acceptance of what it is possible to control or not as an educator sparked my interest in a framework for role modeling. In particular, I think it strongly connects to how I focused on themes of awareness and intention, lack of representation of ways of being, and considering how others may be able to model what we cannot represent. Perhaps my negative thinking when feeling overwhelmed affected my language too, reflected in, e.g., the words I chose to use in my work. For example, in my framework, I used the word “inadequate” to refer to someone who “fails” to be emulated. Both “inadequate” and “fail” are quite harsh words that may reflect the harsh language I would use towards myself. Nowadays, I would have used kinder terms, reflecting the kinder view I have of the struggles of both myself and others.

As part of a multicultural family and having lived in three countries, I have experienced the importance of context and culture. Originally Spanish, I studied computer engineering in Spain and later as an exchange student in Sweden. After following with a two-year period as a teaching and research assistant there, I spent one semester teaching at a private university in the USA, to then start my Ph.D. back in Sweden. I often navigate multicultural environments where it is easy to get lost in the assimilation of culture, unsure of how much of one’s original culture to keep. Again, role models have been very useful as examples of how to navigate this. I was especially interested in how context plays a role, particularly in emotions and care. For instance, I sometimes feel that I am not able to express anger in Sweden as I would in Spain. This is because I think that in Sweden, the way I show anger can be perceived as expressing rage instead, so I have to “tone it down”; I feel that I have to be careful with how I show care, as Swedish people have a more independent approach to it than Spaniards do (in my experience, the latter is much more focused on community²). Emotions are present in Paper V, while care is present there and

²If the reader wants an example, here is one from my first semester in Uppsala, when I fell from my bike. In my experience, bystanders in a Spanish context are socialized into coming to help lift the bike and asking if the person who fell is OK. In contrast, in this instance in Uppsala, my perception was that several bystanders very clearly pretended to look the other way and did not check on or help me. Different Swedes told me later that this had to do with allowing independence: the bystanders probably wanted me to feel like I could solve this situation as an independent person who only “bothers” others when really needed. Regardless of whether that interpretation is accurate or not for that concrete situation, the explanation given reflects in itself an example of the different ways in which our cultures influenced our perspectives on care.

in Paper IV as well. Even though culture is not one of the most prominent lenses in my work overall, my own experiences in this sense (with other examples given in the Preface) are one of the factors leading to proposing the project resulting in Paper V.

It is in Paper V that I made the most use of my previous voluntary work. Since I had the privilege of not needing a paid job during my studies, I instead spent time volunteering for ACM, the largest professional organization in computing. Here I highlight that my work included that within its council on women in computing, ACM-W³, organizing events, coordinating teams, etc. Role modeling was a big part of this (as explained in the Preface). It was also a setting where the main, or even only, reason for people to be part of a team was simply that they wanted to: they thought the work was important, relevant, rewarding, etc. Nobody was forced nor paid to be there. If someone was not comfortable, they could simply leave. Over a decade of experience in this kind of setting gave me a big advantage in leading an ITiCSE Working Group with Päivi Kinnunen and Anne-Kathrin Peters. What I had learned from what was role modeled by ACM(-W) volunteers and by those part of safe and caring research spaces like the ESERA SIG 5 writing group⁴ in which I participated made me pay special attention to ethical considerations toward, for instance, the members of our ITiCSE Working Group team. As I have not often encountered these types of reflections in Ph.D. theses in CER, in Section 3.3, I include them.

Part of these considerations includes caring responsibilities, which in my case connect mainly to parenting. I have been pregnant and on parental leave twice during my Ph.D. studies, which changed my perspective on what it means to care for others and oneself. Taking care of my children sometimes implies incompatibility with academic events organized during pre-school pick-up or family dinner times. I have also prioritized family time and related responsibilities over, for instance, conference in-person attendance. However, the privilege of being able to afford a good workspace at home has allowed me to greatly benefit from the flexibility of the relatively recent hybrid organization of these events.

In terms of communication, my reflections relate to the three languages in my life: Spanish (as a native speaker), English (as learned for work), and Swedish (learned later and less developed than the others). Considering my professional life described above, I came to Sweden with relatively basic English and focused on developing that before I could do the same with Swedish. It is mainly English that I have used in my professional life to study and work for the last decade. Nowadays in my private life I need to switch between the three languages, sometimes during the same conversation. This has led to

³See <https://women.acm.org/>

⁴SIG 5 is ESERA's Special Interest Group on Science Identities. See <https://www.esera.org/esera-special-interest-groups/>

several consequences. Mainly, that 1) I am always, to some extent, uncomfortable with language (as mentioned in Section 3.4), and 2) that my use of one language contains traces of other languages, such as the long sentences in my writing in English that surely come from my speaking and writing habits as a Spaniard⁵. Writing this thesis I have often wondered how much to adapt my English in this sense; I have chosen not to erase signs of my culture(s).

Other communication considerations relate to inclusion. I use the pronoun “they” when the gender is unknown or neutral, e.g., “the teacher themselves” when describing any teacher as a potential role model. In concrete examples in some of the papers I favored “she”. For instance, I do so in Paper II in several examples. There, if I needed to distinguish from a previous example I used “he”, e.g., one example uses “she” and the one right after uses “he”. For this and other papers, I have received reviews that included how “confusing” the use of singular they was for the reviewer, so they suggested that I rephrase. In this thesis, I have included examples with a set of three pronouns: they, she, and he. In terms of pronouns for actual people (as opposed to fictional examples), e.g., when citing someone else’s work, I usually refer to the person by name and avoid pronouns, unless I am sure that I know the ones that they currently use. As Spanish in my mother tongue, I use ending in “-e” for a gender-neutral plural when using these terms in an English-speaking context, e.g., *Latine*⁶.

As for inclusive language considering identities other than gender, I am applying the knowledge I continue to acquire. For example, I revised this thesis trying to avoid ableist language (such as how I started describing role modeling as “visible” and changed to, for instance, “salient”, “noticeable”, or “prominent”) or terms considered to have colonial connotations (such as stakeholder, which I very recently learned about unfortunately after having used that term in other publications). Part of my work towards making my language and how I express myself more inclusive is attending workshops and other training on inclusive practices, and, what I consider most important, listening to what marginalized individuals from these communities tell us is their experience of what is in/excluding.

Lastly, in terms of language, I also try to own my perspective and positionality by favoring active voice over passive voice in this thesis. I use the pronoun “I” to take responsibility for my work and perspectives, but I switch to “we” in some instances to give due credit as well.

For my work overall, my experience as a person with all these different identities and experiences is that my search for and use of role models is not necessarily for examples of extraordinary behavior. Rather, it is simply for

⁵As I perhaps just demonstrated in this last sentence.

⁶More information on the different uses of *Latiné*, *Latinx* and similar terms can be found in Villanueva et al.’s guest editorial [150].

ways to navigate situations where I sometimes felt like I was drowning or like I needed a way to expand my view on what was possible in various contexts.

4.2.2 Doing research

In terms of paradigms, my work is mainly situated within the understanding and interpretation paradigm, according to Kinnunen's ecology in EER [104], in turn based on Bredo's [19]. One of the research approaches within this paradigm is phenomenography, which is explained in more detail in Section 3.2. It is not surprising that I started my Ph.D. thesis with phenomenography. As a member of UpCERG (the Uppsala Computing Education Research Group), I was surrounded by examples of researchers that had used a phenomenographic approach for their own Ph.D. thesis [29]: Anders Berglund [12] and Anna Eckerdal [32] as the first two Ph.D. theses ever defended in UpCERG, and later Jonas Boustedt [17] and Anne-Kathrin Peters [110]. Except for Boustedt, all have advised me formally or informally. In parallel, I was part of UpRISE (Uppsala Research School in Subject Education) and other research networks where thematic content analysis was widely used (especially as it is recommended for early career researchers [18]). Thus, I made use of approaches and methods that both seemed to fit my research questions and about which I could consult others around me.

While not the main paradigm in my work, there is also partly a critical approach [104] in some of the publications included in this thesis, besides in the thesis itself. It is important to me not only to understand but also to question practices and encourage change in computing and engineering education, particularly from the perspective of educators. Computing and engineering come from positivist traditions and signs of this perspective are still present nowadays. Here I think of Donna Riley's words on feminist ethics (including care ethics) in connection to epistemologies in engineering, which reflect my choice to include care ethics in my work:

When engineers dismiss educational outcomes related to understanding social context, communicating effectively, and engaging ethical problems, this devaluation is often rooted in a mistrust of or disrespect for ways of knowing endemic to other disciplines. [...] Feminist epistemologies can break the hold of positivism in engineering and open new possibilities for the profession. Until we wrestle with epistemology in the ways other disciplines have, we will be unable to meet larger goals for the profession including producing engineers who are able to fully engage with the social and ethical aspects of their work. [122, p. 203]

Epistemic injustice also refers to who is seen as knowledgeable (as in the example above) and who is not. I have dedicated time to follow academics of varied backgrounds in social media, as more room for more voices can be

found there than in more conventional spaces. This has led me to research that otherwise would have been less prominent in other venues. I have also learned, first on Twitter and later on mailing lists and journals, about, for instance, the need to make room for epistemologies, methods, etc. that are excluded from CER in its current form and yet are common among marginalized groups [125].

After the beginning of my Ph.D., while I was still influenced by the local research environments I described above, I also expanded my networks. This includes both participating in communities outside of CER and EER, such as ESERA, and attending new (for me) conferences within CER and EER, such as IEEE's RESPECT (Research in Equity and Sustained Participation in Engineering, Computing, and Technology) on broadening participation, and IEEE's LaTiCE (International Conference on Learning and Teaching in Computing and Engineering), aiming to bring CER and EER to countries outside the parts of the Western world most commonly chosen for scientific gatherings around these disciplines. This exposed me to new influences and made me more aware of how much I am missing from other communities. It also showed me how much privilege I have by being in a group that can afford my attendance to these events (held in languages and locations accessible to me⁷, e.g., no extra requirements due to visas). It was mainly (but not exclusively) in these communities that I learned towards the end of my Ph.D. about anti-colonial practices in research and the decolonization of science and engineering. I plan to continue learning in this direction in a way that this approach can be more prominent in my work.

Being part of different research communities makes more salient the question of who is perceived as producing knowledge and is valued for this. Perhaps a telling sign that I am embarrassed to admit is that, whenever I saw a highly cited author's name, I immediately assumed that this author was 1) a white cis man and 2) dead long ago. I had grown up assuming this was the kind of person from where the knowledge we all aspire to obtain comes (a connection again to role modeling and power). A lot of unlearning is needed to combat that perspective and this realization has added a critical lens to my work.

When writing positionality statements and doing research with participants, there is a debate connected to the position of the researcher within the context being studied, i.e., whether the researcher is part of the group or not. That is, how does my belonging (being an "insider") or lack thereof (being an "outsider") to the studied group affect my research? For example, what knowledge do I not notice because, as an insider, it is obvious to me and taken for granted? Holmes [58] summarizes this debate, including the perspective that a combination of identities makes it harder to simply distinguish between these two

⁷As an openly non-binary person from the last year of my Ph.D., the number of places where I would travel has been reduced since then.

positions, that one is exclusively either an insider or an outsider. For instance, when I interviewed teachers at my department in Sweden (see Chapter 3 for details), my non-Swedish background made me an outsider to Swedish teachers and an insider for immigrants; but some of the same immigrants could consider me an outsider because of my gender.

Also, as Herod writes [57], cited by Holmes [58], a researcher can manipulate their positionality, “play” with it, choosing to some extent how to be perceived. In my case, as described above, I had prior teaching experience as responsible for several courses. Thus, when conducting interviews, I could choose between mainly two options. Maybe I wanted to disclose my prior teaching experience to my interviewees. Or perhaps I could simply let them think about what they could assume: that I, as a Ph.D. student, had a bit of teaching experience as a teaching assistant or even no experience at all. I decided not to disclose this information. I wanted to be seen as enough of an insider, i.e., that I was aware of how teaching was conducted at the department to some extent. But I also wanted to be perceived as enough of an outsider, so that the teachers would explain to me things that otherwise may have been taken for granted and I may not have known. I hoped that this choice also contributed to interviewees seeing me as “harmless”. The more “amateur” and “powerless” that I was perceived, the (hopefully) more likely that the interviewees would feel comfortable disclosing negative views about their job without fear of repercussions triggered by me. In Section 3.4, I further reflect on how being perceived as an insider/outsider may have affected my work.

4.2.3 How my research affected me and others

How my research affected me and others is partially addressed in different parts of this thesis, such as ethical considerations towards myself. I summarize here some main reflection points.

In my personal reflections and in discussions with co-authors, the most common topic was how extra aware of our own potential role modeling we became. We started analyzing more what we could be transmitting to others, such as students and colleagues, and how these attitudes, behaviors, etc., corresponded (or not) with how we regarded ourselves and who we wanted to be. At times this meant that we could feel more pride, realizing that we modeled something (in our interpretation) positive and beneficial for others. Other times, it led to feeling overwhelmed. We were not sure how we were perceived, the extent of our (perceived as negative) effect, how much we could really control all of this, etc. A concrete example comes from work on Paper V, where we were looking at well-being practices displayed by educators. I realized that I was asking everyone in our research team to prioritize caring for themselves over the work on the paper when needed; but when we got closer to the deadline, I added that I would take the extra work we aimed for that

deadline, as I considered my responsibility as a leader and this would allow others not to push themselves. That is, I was asking others to follow well-being practices that I did not apply to myself, that I was not role modeling. I was immediately met with two solutions: either more people stayed to finish the work or we simply decided that we could not work more for that deadline.

Similarly, during data collection, some educators expressed that they had not reflected on their role modeling before participating in this research, and thanked me/us for the opportunity to do so. I can only hope that they are now kind to themselves in these reflections, overwhelming as these can be, and can make further use of our work.

5. A framework for role modeling in computing and engineering education

In this chapter, I present a framework for role modeling that conceptualizes this phenomenon. This framework addresses ORQ: *How can role modeling in computing and engineering education be conceptualized, as seen from the role model's perspective?*. The sections include answers to RQ1 (What can educators in computing and engineering role model?) by considering what can be modeled both in theory and in practice. The latter is taking into account RQ2 (What are obstacles that affect what is role modeled by educators in computing and engineering?) when showing how the contexts of computing and engineering education and the concrete circumstances of each educator can affect the gap between what could potentially be modeled versus what is seen as feasible or desirable.

It is essential to highlight that, as we write in Paper I, “Role modelling is not explaining competencies or traits but making them perceptible and concrete to the student who may want to have them”. Role modeling is about what is observable and potentially possible to emulate. Considering this perspective on role modeling, this chapter starts by describing the work in Paper I that led to the framework described in the rest of the chapter.

5.1 Understanding role modeling as a teacher in computing

By using a phenomenographic approach (see Subsection 3.2.1) for Paper I, we produced an outcome space showing different understandings of role modeling as a teacher as the embodiment of certain characteristics (traits, skills, or qualities). Here embodiment means that something abstract (such as a trait) is made concrete through the example that the role model represents. Thus, role modeling as a teacher in computing is then understood as the embodiment of:

1. Knowledge of the subject domain
2. Transmittable interest for the subject domain
3. Personal attributes related to a professional in the field
4. Potentially subpar behavior and flaws
5. Characteristics only (or more prominently) for a subset of students similar to the model
6. Qualities that may affect and be affected by society and the profession

Category (from least to most complex)		Focus	Awareness and control over modeling
1	Subject domain	On subject domain	Conscious and controlled embodiment
2	Transmittable interest		
3	Personal traits	On perception by others	Unconscious and/or inevitable embodiment
4	Subpar/flaws		
5	For subset of students	On context and impact by others	
6	Society/profession		

Table 5.1. *Different understandings of role modeling as a teacher, from least to most complex and with different foci (adapted from Paper I).*

This list shows categories sorted from least to most complex level of understanding of role modeling as a teacher in computing, as listed in Paper I. In Table 5.1, we see that each pair of consecutive categories can be seen as having a different focus: on the subject domain (categories 1 and 2), on perception by others (3 and 4), and on context and impact by others (5 and 6). The first three categories are also related to the conscious and controlled embodiment. We interpreted this as the teacher knowing and feeling in control of what the students perceive and do not perceive as modeled, e.g., the teacher shows programming skills while also avoiding telling the students about their personal life habits, e.g., drinking with friends. In contrast, the last three categories in the outcome space fall more into unconscious and/or inevitable embodiment. Our interpretation was that teachers had a more advanced understanding of role modeling when they knew that students might perceive as modeled more aspects of the teacher than the teacher could control or was even aware of, e.g., behavior that could be seen as a flaw.

This outcome space shows how role modeling as a teacher can be understood. The hierarchical structure of the categories fits research on how new teachers may focus on the subject. Computing education has been focused on the transmission of knowledge and skills, and educators tend to unconsciously teach the way they were taught [115]. Through experience and training, they start to incorporate other understandings of their role as educators.

While the outcome space captures the experiences in the interview data I collected at the beginning of my project, it does so in a linear structure; it implies that more complex understandings (such as considering how society and the profession are affected) require less complex understandings (such as role modeling transmittable interest). This interpretation comes primarily from our argumentation at that moment, and from some interviewees having a similar view, such as wanting to be seen as knowledgeable in programming and role models that would affect society based on these displays of knowledge. Later on, after coming across other research and experiences, my perspective changed. I saw that the outcome space reflected an understanding of role modeling where the higher categories include considering the broader context, including the diversity of students and the impact of one's own role modeling

in society. A different order in the categories was possible, as this hierarchy depicted a view that may not correspond to teachers from marginalized groups. For example, care ethics point to individuals who are socialized as women as being also socialized into care; thus, they may already have this broader view of considering students' needs outside of the curriculum, regardless of their other possible understandings of role modeling as a teacher, such as presented in Mariskind's work in higher education [86], and Günter's work [54, 53] on gender differences among biology teachers when they consider what students in higher education need to be/become a scientist. Individuals with marginalized identities may have experienced being perceived as role models for others with whom they share identities before beginning to formally teach. Similar reasoning can be applied to awareness and control of role modeling, which is presented relatively linearly when using the phenomenographic lens.

I moved towards a non-hierarchical representation of role modeling in computing and engineering education to add a different perspective that was not as linear a structure of understanding. This representation is a framework divided, as presented below, mainly into areas that address questions connected to who is part of role modeling, what can be modeled, how it is modeled and perceived in the particular context of computing and engineering, and how an educator may attempt to plan their role modeling.

5.2 A framework to reflect on role modeling

As a complex concept, role modeling can be conceptualized by addressing different questions. In this section, I separate these (sometimes quite interconnected) questions to guide the reader through various steps that they may take when reflecting on role modeling in the contexts of computing and engineering education. For instance, I start with who is mainly part of role modeling, moving to what should and what can be modeled, to go back to the question of who from a different perspective, considering social contexts and norms.

This section contains a series of questions connected to the framework that can be addressed in this order, a different one, or just partially, depending on the goals and circumstances of the person(s) using the framework.

As for who is envisioned as a user for the framework, I do not see this as exclusively an academic profile. The framework is also meant to be used by practitioners, who may not necessarily be DBER academics and may thus use certain concepts in different ways (as highlighted in Chapter 2), such as giving different meanings to the concept of competence. Even when given a definition for a term such as role model, research participants may still use their understanding of the term [20]. Thus, I have aimed to use words for the framework that are as close as possible to those used outside academic circles.

The different dimensions of the framework are detailed below. Chapter 6 contains examples of different uses of the framework. Paper II contains the

main description of this framework, building on the outcome space from Paper I described above and complemented by the work in Papers III, IV, and V, as described in this section.

As opposed to previous work focused on the perspective of the person observing a role model, this framework is developed from the perspective of the role model. This perspective is in line with my aim for a framework for scaffolding reflections on one's own role modeling (whether actual or potential) and, overall, to have ways of describing what role modeling is in a nuanced way. In this thesis, the role model is considered to be mainly an educator, but the framework (as seen in the examples in the examples in Chapter 6, can be applied to other role models, such as students as role models.

5.2.1 Role model and emulator: who is (mainly) part of role modeling?

In a simplified view, there are two main actors in role modeling: the person observed and potentially emulated, and the one doing the observing and deciding whether to imitate or avoid imitating what is observed. In my framework, I refer to the former as role model and to the latter as emulator. I have defined role model (as detailed in Subsection 5.2.8) based on the work I describe in this thesis. As for emulator, others have used other terms, such as role aspirant [94]. I have chosen a term that prioritizes a focus on emulation (imitating or developing even more than what is observed) over the view of role modeling as confined to a specific role.

There are of course other actors in role modeling. For example, the ones who observe the role models and/or emulators. In one of the interviews I conducted with educators working in Sweden, Joe¹ describes his view on his colleagues' role modeling:

I remember, this was a student who started, he remembered sitting in meetings discussing research where people were being really aggressive and he thought: "OK, this is the way I have to be, just start doing the same thing". So the people who were being aggressive, they were role models whether they wanted to be it or not, they were bad examples of how you should behave.

Joe was not a central part of this (as he perceived it) aggressive role-modeled behavior emulated by the student. But he still observed both the role models (colleagues) and the emulator (new Ph.D. student) and judged what happened, i.e., evaluated it as "bad examples". Conversely, we may describe certain individuals as examples that others should follow, e.g., in the interviews, various teachers referred to guest lecturers in their teaching as role models that they

¹As described in Section 3.3, I assigned pseudonyms to each participant that reflect whether they are Swedish and their legal gender.

hope their students would imitate in some way. In these situations, we still need a shared language to describe role modeling with more nuance, which I address in this section.

Finally, and still as a simplification of a complex phenomenon, there are other actors in role modeling. They have different levels of capacity to effect change (both positive and negative), i.e., power. Everyone who is part of a community may have an effect on the role modeling of others, by sustaining norms, by showing rejection of representations outside the norm. Especially those who have more power, such as managers, are to be considered, as their decisions may affect, e.g., who gets more space and/or recognition as a role model. Conversely, we can consider those who get affected by role modeling, such as when role modeling has an impact on how a professional affects society (as some teachers reflected in the interviews).

I have now established all the various actors in role modeling. While the framework can be applied to other combinations of actors, for the rest of this section I mainly focus on educators as role models and students as emulators in computing and engineering education.

5.2.2 Awareness and intention: how is role modeling done?

Educators can be role models whether they are aware of it or not, and whether they have that intention or not. These dimensions of *awareness* and *intention* (originally labeled as awareness and control in Paper I, as described above), can be seen as two spectra that can be combined.

The spectrum of awareness refers to the degree to which the role model knows that they are modeling something; the spectrum of intention refers to the extent to which the educator wants the students to emulate what is modeled. Figure 5.1 shows how these two dimensions combined result in a two-dimensional field of awareness and intention, with role modeling as:

1. Aware and intentional: the educator knows they are modeling something and wants the students to emulate it.
2. Aware and unintentional: the educator knows they are modeling something and does not necessarily want the students to emulate it.
3. Unaware and unintentional: the educator does not know they are modeling something and thus cannot have a plan for students to imitate it.
4. Unaware and intentional: as above, lack of awareness makes planned intention impossible.

Role modeling that the educator is aware of and has the intention for students to emulate is easily connected to knowledge of the subject. Gustav says in his interview that he models certain competencies in a way that, hopefully, the students can emulate:

[...] so I teach [course] and then of course I want to, in some sense, be a role model for, I want to [show how I use course content myself] so that [this] can be mimicked, if you see what I mean.

Behaviors that are planned in teaching but are not necessarily to be acquired by the students fall under the aware and unintentional area of role modeling. In his interview, Alex mentions making jokes as an example of something that the educator does not plan for the students to imitate, but the educator is also not necessarily opposed to this imitation:

I think my behavior is very important. I think I actually base most of my teaching results on behavior. Like acting stuff. But I think it's... I mean, that's not something to emulate. You see the point. So... I think it is very effective when maybe you make a joke [...]. Then of course if someone says 'I would also like to teach and make jokes' that's maybe fine but that's not the point. That's not what I'm trying to achieve there.

Tage, on the other hand, is aware of role modeling some things that he later feels bad about, as he did not have the intention, could not control them, and this can be overwhelming:

So I mean you take on a lot of responsibilities, being a teacher. Which I feel it can actually... feel a bit heavy at times... Whenever I feel it that for whatever reason, whether, if it is for reasons outside my control, or because of something of my doing, so to speak, I feel I... performed under par in teaching, I feel bad about it. Because I feel I haven't given to the students what they have a right to expect of me as an academic teacher. [...] I think that ultimately I have a sense of having wasted their time. But of course in, in more immediate terms, mmmm that I'm not being able to convey... The knowledge or skills that I wanted to.

As for unaware and unintentional role modeling, when Joe refers to his colleagues' aggressive behavior (as above), he says "So the people who were being aggressive, they were role models whether they wanted to be it or not, they were bad examples of how you should behave". One interpretation is that his colleagues may not have been aware of their (as Joe interprets it) aggressive behavior being imitated. They could have been unaware and thus have no intention of role modeling this behavior.

All of these are options for what the educator is currently modeling. A question that arises from using the lenses of awareness and intention is how an educator can move from lack of awareness to awareness. Another step is to bring light to that which could be modeled by the educator but is currently not salient: what can be made more salient (perceivable) and/or easier to notice how to emulate? Concrete examples of these kinds of reflections are given in Chapter 6. All of these questions are connected to what the educator is capable of modeling. Trying to choose what to model comes, though, after

another question: what *should* I model? Notice that Joe above refers to his colleagues as “bad examples”. How can we as educators become good (as opposed to bad) role models?

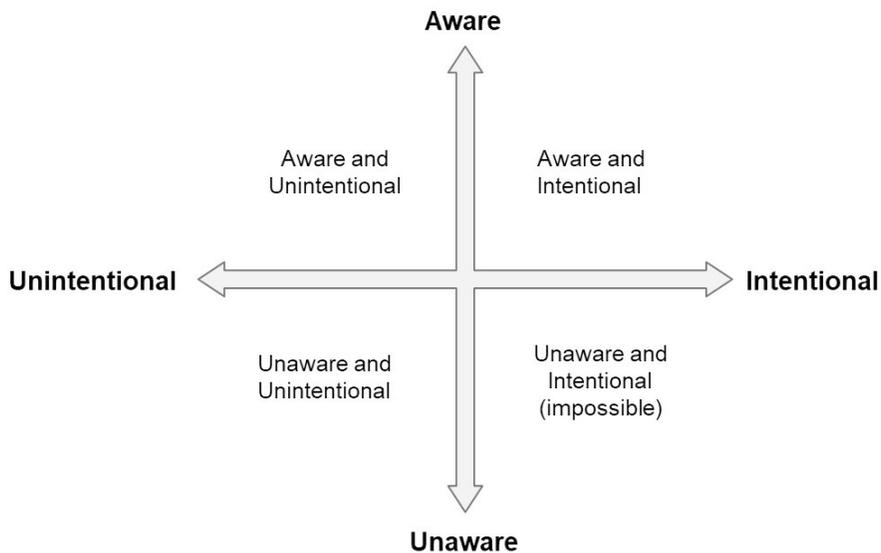


Figure 5.1. Framework: combined dimensions of awareness and intention of role modeling (adapted from Paper II, where the original image is © IEEE 2018).

5.2.3 Positive, negative, and more: what is a good/bad role model?

It is tempting to focus on how we can be seen as “good” role models and avoid being perceived as “bad” role models. But what we mean by these adjectives can be more nuanced than initially considered.

When the adjective “good” is used for a role model, it refers to role modeling as the embodiment of something that the emulator 1) will and/or 2) should emulate.

Those that are emulated by the emulator are positive role models. When I asked Robin in her interview about who she thought her students’ role models were, she thought that she and other academics can be positive role models for their students:

[...] so I think that’s some of them [the students] think positively about... Because some of them actually ask [Robin and others] about research and they want to know about that, then they are like... they want to be that or they are like ‘oh how did you do that?’, which to me signals that they want to either do it later or not do it later or something.

To refer to individuals who are seen as examples that should be followed, regardless of whether potential emulators actually do emulate these individuals, I propose the term “endorsed role models”. For instance, in his interview, Alex mentions students who have taken a course before as examples that he thinks current students should follow: “I think it’s important to involve [in the course] previous students. [...] So, show what people who got similar experiences here, similar studies, achieved.”

For “bad” role modeling, I present four interpretations based on both the literature on role modeling and examples in my data:

1. detrimental role model: the role model represents something that the emulator sees as good and consequently emulates, whereas an external observer deems the role modeling (and emulation) detrimental for the emulator. In the example above, Joe is the external observer who thinks aggressive behavior by colleagues in a meeting is detrimental to emulate by the new Ph.D. student in the group, but thinks that the Ph.D. student imitates the aggressiveness anyway.
2. negative role model: the role model represents something that the emulator sees as a way to prevent them from reaching their goal. Thus, the role model represents what to avoid doing/becoming. This is as defined by Lockwood et al. [76]. The definition of role modeling that Gustav gave in his interview includes this view: “I guess there are also negative role models when people do things in a way that you certainly don’t want to...”
3. inadequate role model: even when the potential emulators perceive that they would be able to emulate the role model, they do not; the role model with an intention to be emulated is, in fact, not imitated. An example is when students see a teacher as competent in some way but are not interested in acquiring that competence themselves. Some teachers in the interview were aware of this in the context of different students having different goals and, thus, role models.
4. unattainable role model: the potential emulator does want to emulate the role model but sees it as impossible even with time and/or effort. Attainability of what the role model represents is needed for role modeling to work [75, 45]. Gustav says in his interview that he purposefully uses as examples in his teaching “papers by people who have [the students’] own level [...]. If you [as a student] start reading excellent papers, then you might think ‘Oh, I’m rubbish’. So in that sense, even a good role model can be a bad role model.”

In other words, in terms of emulation:

1. a detrimental role model is emulated as something the emulator wants to achieve, even if others disagree with the view of this emulation as positive.
2. a negative role model is an example purposefully avoided. To be a successful student, Student A will do their best to avoid failing an exam

like Student B did. Gustav refers in his teaching to work by previous students as “ examples [of work] that are used for criticism.”, as Joe does and quickly clarifies “Not naming anybody” but rather presented as “here a common flaw is...”.

3. an inadequate role model is not imitated but not necessarily avoided either. It is, simply, ignored. A teacher showing care for the planet, wanting their students to also care, may not be imitated. As opposed to purposefully avoiding sustainable practices (as in negative role modeling) modeled by the teacher, the student(s) simply will not think much about caring for the planet from the example represented by the teacher. Notice that an inadequate role model refers to the feeling of inadequacy that the educator may have when they intended to be emulated but were not. In the survey, some participants did not feel they were role models.
4. an unattainable role model will not be imitated either but for the lack of feasibility represented. Joe thinks similarly about professionals as role models for the students: “And then also you’re probably aware that the negative impact that that could have is that then ‘OK, so... [this person] is really good at making great computer stuff. What about us [the students]?’ [...] That may be a negative thing.”

Thus, educators may be positive and/or endorsed role models in some ways; they may want to avoid becoming detrimental role models to the extent that this is possible; they may be negative role models in some ways, simply because different students have different goals and one educator cannot represent all of them; they may be inadequate or unattainable role models for some of what they can represent, and can then explore other ways to transmit this to the students, if possible.

In his interview, Alex mentions case studies in his teaching as a way of providing students with examples of what should and should not be done as professionals. This means providing the students with endorsed role models, and hoping that the examples Alex sees as detrimental are not emulated by the students. Alex also mentions how certain role models can be detrimental to students because, for instance, he thinks it is a bad idea for students to drop out of university as an imitation of some famous entrepreneur. He uses a sarcastic tone when he gives an example of a student’s reaction he imagines:

[If the student reacts to the role model as] ‘Oh now, I will go in my garage, my car box, and stop university, and try to go and study design and then revolutionize CS [Computer Science]’ then maybe not [a good reaction] *laugh*

Alex continues to reflect on himself and others as detrimental role models, when failing to incorporate in teaching aspects that he deems very important for the students’ education. In his case, it was not until recently that he incorporated ethical considerations in his courses, and seems concerned about the consequences for society:

[As a teacher you should] check if your students are going to get it [ethics or other competencies] from somewhere else. And in my case it was no until recently. That's problematic, I think. Because we are shaping the society, no? [...] A lot of things in our society are informed and run by information technology, so the people who developed these things, if they don't think of the things they are going to [do][...]

Tage has similar thoughts on professional competencies:

[...] there are a few skills which are not connected with any particular course mmmm the study of it is supposed to be taken up in every course, like the skill of doing written and oral presentations, and that's really very difficult because if it's, if it's everyone's responsibility then it's no one's responsibility. Unless you actually make a detailed plan for this. How it should be included in the various courses. Which I think would be a bit difficult for, for lots of reasons.

While Alex describes lack of role modeling (of ethical considerations) from how an individual teacher can reflect on it, at least partly as the responsibility of the individual, Tage puts the focus instead on how this happens because of the way the system is (not) planned and whether it is even feasible to achieve this role modeling of professional competencies across courses.

Robin relates to the vulnerability of role modeling as a teacher, of modeling something that can be perceived as detrimental or negative, but has a more optimistic perspective on at least parts of it:

Teaching is dangerous. *laugh* because you are exposing all of your weaknesses. I mean, if you have a weakness then the students are going to find it *laugh*. [...] because all of the spotlight is on you. [...] teachers are not perfect. They are there to help you but that's it, they don't know everything. [...] Mmmm so showing them [the students] that you are imperfect is very important I think.[...] I think it's dangerous [to transmit that the teacher is perfect]. Because I don't think you should teach people to believe stuff, I think you should teach people to evaluate things because yeah...

Robin thinks that guest lecturers, presented as endorsed role models, can actually become negative role models because of what they represent during a presentation to students comes across as negative, and this is bad because it does not represent the reality of that professional's everyday work life:

The problem is that in practice guest lecturing does not usually work. It usually does not provide a good role model because it shows someone who's really stressed about their work and their company and they come and say like 'oh blah blah blah blah blah' and then people think that, people get that impression that 'okay, they are stressed, they work a lot, we don't want to be like that' but it's not truthful [representation of what it is like to work in that company].

But sometimes, Robin clarifies, negative role models are good for the students, to help them decide what path(s) to take: “or you realize [when seeing a role model’s example] like ‘oh dear, I really didn’t want this’.”

Gustav thinks that teachers may fail to be role models (becoming inadequate role models) in terms of, e.g., programming competencies:

Most of us [...] are pure academics[...]. Many, many, I think, could only write a really short program [...] this is in... in some situations, a real problem. We need to be able to teach our students to deal with huge program systems and most of us can only do that in very general... small ways.

These examples and argumentation show that role modeling is complex, and an educator is not simply a “good” or a “bad” role model. Still, we may want to reflect on what is “the right thing to do” when it comes to role modeling. Or, as Gustav expresses it in his interview, role modeling involves “being a correct decent person.” Ethical theories can help approach the question: How can educators decide what to try to model?

5.2.4 An ethical approach: what should educators model?

In the interviews, Tage says: “Most of [the students] will end up out in society in some kind of jobs and of course it is my duty to, mmmm, make sure that they have the necessary skills to do that effectively.”. The “right thing to do” as a teacher, in Tage’s view, is to provide students with what they need to be professionals, and Tage does that partly through aware and intentional role modeling. Thinking of duties is an example of (consciously or unconsciously) making use of ethical theories to guide one’s intentions and actions.

As educators, we are observed and potentially emulated. When we are aware of this fact, as Tage, we can then use ethical theories to guide us in our reflections on how we want to act and behave as role models. To encourage teachers to engage in this kind of reflection in a conscious manner and supported by theory, in Paper IV we make use of three different ethical theories (virtue ethics, care ethics, and ethics of freedom, the main points explained in Chapter 2) that we connect to role modeling as a teacher. These theories, chosen because of their focus on personhood, are presented as different lenses that lead to different perspectives, rather than us integrating the three of them into one theory.

A virtuous teacher will aim to embody virtues, and desirable character traits, as an endorsed role model. Sometimes this is done as the balance between two virtues, e.g., the persistence to work on a project and the humility to know when the project stops being feasible [108]. This teacher will also aim to avoid becoming a detrimental role model, i.e., modeling vices, and undesirable character traits. Students can then emulate virtues and avoid developing

vices. As examples from the interviews I conducted, Gustav mentions modeling being fair, while Joe refers to how he avoids mentioning to the students habits that could be seen as vices even if these refer to behavior outside the teaching setting: “I try to be a bit personal... I do also limit it... No drinking stories *laugh*.”

A caring teacher will focus on relationships. They will show that they care for someone (such as students, colleagues, users, animals, or plants) or something (such as devices or the planet). They will embody achievements and aspects that are part of identifying and addressing the students’ and others’ needs, such as their attentiveness, responsiveness, or willingness to take risks. This is something that the students can emulate, even if each caring relationship is different. Not showing care is also role modeling, and it can be a statement, e.g., not showing care for the planet can be seen as role modeling the attitude that this is unimportant. As in the example about caring for the planet (or Alex above referring to the lack of ethical considerations in his teaching), sometimes this kind of role modeling is part of the hidden curriculum [149], role modeling values and norms present in the discipline [33]. In Paper IV we present examples of both showing and not showing care, and why, as experienced by educators in computing. This is also summarized in this chapter.

When we consider Biesta’s purposes of education (see Chapter 2), we see that teachers may model knowledge and skills (connected to the purpose of qualification), and traditions within the community (socialization). But if they stopped here, this would lead to education being about “perfect reproduction” of what already is; Biesta goes as far as to refer to it as indoctrination [14]. However, the teachers can also represent subjectification, embodying ways of doing and being that are not pre-established, producing rather than reproducing; and this approach can be emulated by the students. As an example from the interviews, Robin explains that she purposefully avoids role modeling perpetuations of gender norms:

I refuse to take on certain administrative duties because they are stereotypically taken on by women [...] I do not want to show to [others] that ‘Oh, you know, I just do things for no credit’, so this is important. [...] saying no to things to not perpetuate stereotypes.

Knowing what kind of lenses we can use, and how, to guide our reflections for what to try to model, we can then consider 1) what types of role modeling are virtually possible to represent and 2) in actuality, which ones educators see themselves as able to embody.

5.2.5 Achievements and aspects: what can be modeled?

When thinking about what can be represented by a role model, in his interview Joe touches upon different approaches:

Mmmm [a role model is] someone that you can look to for examples of how to behave or maybe inspiring behavior or inspiring kind of attitudes. Someone you can look to and say that ‘Yeah, this is somebody I would like to be like’, in some sense. Not necessarily completely but... Attributes or personal characteristics you would like to sort of imitate. Maybe that’s the wrong word.

While Tague mentions knowledge and skills in his definition of role model, Joe is referring to sources of inspiration, behavior and attitudes, and personal attributes. While I interviewed the teachers, I realized that they referred to these various concepts (and/or similar ones) not always in the same way; I had to ask for clarifications several times.

When, at workshops and similar contexts, I have guided reflections on what we model as role models ourselves, I have encountered situations in which the same concept was expressed in different ways by different people. Taking empathy as an example, this concept could be mentioned as:

- Person A: I have the skill of empathy.
- Person B: I am an empathetic man.
- Person C: When energy and other resources allow me, I try to have an empathetic attitude.

We can interpret Person A’s view of empathy as a skill, something that they developed with work and that can be further developed. Person B’s approach to empathy seems more connected to who he thinks he is as a person: he is empathetic “by default”. Whereas Person C’s statement points more strongly to context and how her empathy is only exhibited under certain circumstances, not necessarily as a default attitude, and not always successfully. Of course, these are simplifications of these views, as the lines between them are blurrier than that, e.g., Person B can still consider that he has worked to develop his empathy. There is no perfect division of these types of views.

This subsection details the part of my framework that represents what can be role modeled, considering the variety of the examples above and other approaches described. I do not intend to create a framework showing a “perfect”² classification of types of role modeling. Rather, I want a framework where the person using it (whether they think more like Person A, B, C, or something else) finds a metaphorical box in which they can save their own view of what they are modeling. That is, the framework is not intended to show my definition of what, e.g., empathy, is but rather allow for several interpretations of it, based on theory and data analysis. Intertwined with my findings there are the connections I made to different parts of the framework from previous research (see Chapter 2).

Considering what role models in computing and engineering can model for others, I divide this into two: achievements, which are something mainly externally given to the role model, and aspects, which are mainly inherent to

²We would need to define what we mean by perfect in the first place, and whether that is possible to achieve.

the role model. I write “mainly” because I personally consider that nothing is done in complete isolation from others. As shown in Figure 5.2, achievements are divided into objective and subjective, while aspects are divided into competencies, character attributes, and attitudes/behaviors. All of these are described and motivated below.

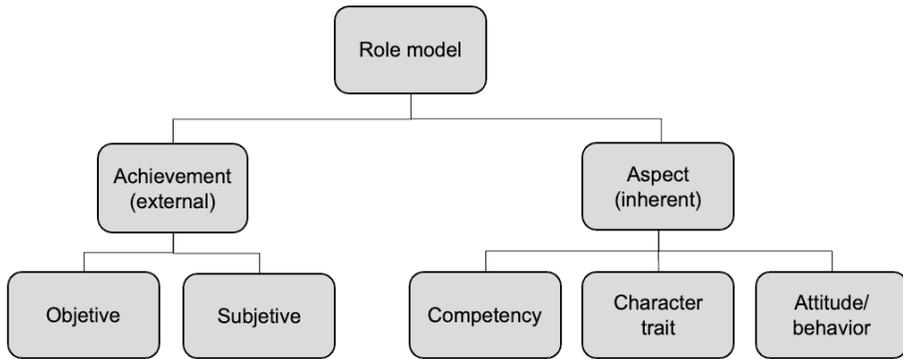


Figure 5.2. Framework: what can be modeled (adapted from Paper II, where the original image is © IEEE 2018).

Achievements

An achievement is a goal that has been reached; the emulator has a goal that is represented as reached by the role model. These can be objective or subjective.

Objective achievements leave no room for discussion, being indisputable facts, e.g., someone receiving an award, having a certain professional position such as Full Professor, or a role in private life such as being a legal guardian to a child. Examples of this in our survey include participants mentioning grants and awards they had received, or referring to their being a parent: “I also have [my four-year-old daughter’s] picture in my office and some of her drawings on my office door.”

Subjective achievements, on the other hand, are subject to interpretation, e.g., being powerful or successful can be interpreted in different ways by different observers. In the survey, an educator says “I regularly tell my students that I’m no better/smarter than them, I just have more experience [...]”, experience being something perceived and interpreted differently depending on the observer.

Achievements are connected to the view of role models as representing what is possible (to achieve by the emulator) [94] or as “living evidence that certain achievements are possible” [89, p. 35]. In her definition, Robin says in the interview: “I think [a role model] is someone that you identify with to such a degree that you can, that you can see yourself or your ambitions mmmm reflected in what that person does”. Joe tells me in the interview about a guest lecturer in one of his courses and how he thinks that the way she described

her achievements (such as participating in a programming context or having international study or work experience) could have had an effect on what the students saw as possible for themselves. He is basing this assumption on his personal experience as a student:

Well, this was... her personal journey, that was the way she gave her talk. So... in the sense of saying, you know, 'If you enter programming contests you get a lot of great experience working on some problem that you never thought of. [...] Go abroad, do a Ph.D. or a master's somewhere else, it's a lot of fun... meeting a lot of great new people'. I think a lot of people never even consider that as an option until somebody comes and says 'that's an option'. Mmmm when I grew up in a small country town, [...] after my Ph.D. finally [I went] into the world. I had no idea of doing it earlier. Nobody said 'this is one of the options'. And I think that... that... might be really helpful to other people.

Social identities can be interpreted as subjective achievements, as something that is (at least initially) inherited from or given by or negotiated with others and serves as an inspiration to those with whom we share identities that are defined in different ways. However, this kind of role modeling is usually expressed in connection to something else. For instance, in the context of referring to the achievements of a woman in a male-dominated context, the achievement is not that the person is a specific gender but that they achieved something in a context where their gender is considered relevant for different reasons and/or more salient. Considering not only gender but age, a survey participant writes: "I hope to demonstrate that my field is not only for men in their twenties." Robin, in the interviews, reflects on her role modeling and how the salience of her gender, depending on the context and perhaps in a binary approach to it, affected which students could potentially emulate her:

Robin: [...] I'm not the norm because there are no women [in some departments I have worked at], which means that every time I appear at my workplace I am a role model for people... for students who see me and see "oh, there's someone here who's potentially slightly like me". [...] when I was in [other department] where there is not this gender difference but mostly women there, no men, then my role modeling is more restricted to the role of teacher, rather than person. [...] I think I am a role model for women to a larger degree. Mmm but I think... sometimes I think that I'm a role model for men but I think... I think it's less important because they have others too. And I think most likely to a lesser degree because of the gender aspect, which means that you more easily identify with someone who's similar to you.

This, in turn, affects how she reflects on her own role modeling:

How to put this? OK, as a woman in a male-dominated environment, gender is a component of you to a larger degree than your gender is a component of you if you're a man in a male-dominated environment because you don't have to

reflect on it as much. [...] [In the other department] I was the norm, so I didn't reflect on being a woman every day. It wasn't a thing.

Robin noted that, in departments with a lack of women, she may be perceived by other women as a role model due to the gender they share, adding that she is likely a role model for women to a greater extent than for men because people tend to identify more easily with those who are similar to them. However, in departments with primarily women, her gender is less salient, and thus her role is more restricted to a teacher's. As a woman in a male-dominated environment, she feels that gender is a more significant component of how she is perceived compared to men in the same environment who do not have to reflect on their gender as much. Conversely, in environments where she is the norm, she does not have to think about being a woman every day.

Achievements of both kinds can be connected to recognition (by oneself and by others) as a response to the performance of competence, as defined by Carlone and Johnson [23]. Objective achievements can be related to recognition by others, where other people acknowledge our achievements as facts. When thinking of recognition by ourselves, the reader may think of impostor phenomenon and the potential disconnection between our official achievements and how we actually feel about our competence connected to the achievements. For example, does the person promoted to a certain position recognize themselves as worthy of said position? Notice then that the focus is on the achievement itself, whereas analyzing what is needed to achieve it is a different part of the framework, as I continue to explain below.

Aspects

In contrast to the external perspectives of achievements, aspects represent something more focused on what is inherent to the role model. The views of Persons A, B, and C above correspond to the three types of aspects I identify. Persons A, B, and C represent different views of empathy as:

- A: a competency
- B: a character attribute
- C: an attitude or behavior

Competency here comprises knowledge and skills, as defined by dictionary definitions of the term, e.g., competency as the “possession of sufficient knowledge or skill” [91] or “An important skill that is needed to do a job” [21]. While knowledge (the “know what”) and skills (the “know how”) can analytically be discussed separately, they are difficult to separate in practice and can be used together [36, 115]. This connects to the view of role modeling as what is salient and possible to emulate, where I see skills as the most salient part but still paired with knowledge. It also corresponds to competence as Carlone and Johnson use the concept in identity research, where competence is knowing what to do and how [23]. In the interviews, Tage says “Generally speaking, [a role model is] someone who knows the subject. And is able to apply the

knowledge.” When speaking of the times where he feels he did not “perform” as he would have liked, he mentions again “not being able to convey... the knowledge or skills that I wanted to”.

Character attributes reflect the view of identity as possessed [114]. It connects to the idea of a core identity, the core of “who I am”, what I do “by default” or, as a general rule, an identity that is stable even if it can be further developed [41]. Character attributes are connected to virtue ethics (as described in Paper IV and Chapter 2), to virtues (desirable character traits) that are cultivated. While a character attribute can then be interpreted as a positive view of who we are, it is also possible to have character attributes that are deemed negative, such as vices. An example of a virtue that a teacher can display is fairness. Gustav mentions in his interview that is important for him to show how he is fair and shows this in the way he treats students, hoping that this is consequently emulated by them:

Because I show what I care about, and [...] to some extent that’s part of being a role model. I want to show that I care about everyone getting their say or treated fairly [...]. So I behave in a “good” way, in a way which I think can be mimicked, if you like.

Behaviors and attitudes are more connected to particular contexts and may differ from that core. For example, we may think that we are calm “by default”, as a character attribute, but we may have anxious behaviors under particular circumstances. This focus on context allows a gentle use of the framework, in the sense that negative aspects of the framework user can be placed as temporary rather than a core part of the person, e.g., I can use the framework to reflect on how I, when provoked, can model a harsh attitude but in general I do not think nor behave in this way: I am not “a harsh person”, just someone who is harsh sometimes. Focusing on context also connects to the view of identity as negotiated rather than possessed [114]: behaviors and attitudes that are contextual and relational, that depend on where I am and with whom I am, a way of performing or doing, for instance, gender [152]. In the interviews, Joe’s mentions an example of how a behavior seemingly harmless (making jokes) can have negative effects (be detrimental role modeling):

We are training academics, the industry leaders of the future and... yeah... I guess they’re going to look at the behavior and say “I guess this is acceptable behavior” and if we behave poorly, maybe making too many jokes, could be an example of poor behavior that can.... yeah. Can have a very negative influence...

While being honest can be interpreted as a character attribute, when Robin describes in her interview a course she designed, she mentions having an honest attitude in that specific context (which she mentions later may not be transferable to other teaching contexts), modeling honesty about how much or little she knew, and hoping that the students would emulate this honest attitude:

[...] but that [course] came out of, I was sick of this pretending to learn things when, when people don't actually understand. So that was kind of amusing for me to do a course based on, based on that. Based on the whole: 'let's be honest about how little we know' *laugh*

Using the conceptualization of professional competencies by Sabin et al. [126] (described in Chapter 2), we see that knowledge and skills can overlap with the competency aspect in my framework, while character attribute and attitude/behavior are more connected to dispositions. Sabin et al. [126] refer to the specific context for a specific task. This is not represented in my framework; rather, the framework gives a relatively high level of abstraction that the framework user can then apply to their specific context(s) and task(s). I do not perceive knowledge and skills as separated from dispositions. But *analytically* I separate them to encourage reflection and emphasize role modeling of dispositions. Since dispositions refer to the socio-emotional component of professional competencies [36], and computing and engineering are seen as rational and logical [101], where emotions [81, 115, 36] and care [122, 112] are important, and defining dispositions helps students understand “what is expected of not just the products of their work but the human, interactive aspects of their work” [36, p. 6], I believe it is vital to bring more visibility to and encourage displays of this kind of role modeling.

5.2.6 Care, emotions, and professional competencies: what do educators think they are able to model, how, and where?

When an educator takes a moment to reflect on their role modeling, they can think about different achievements and aspects, and why the educator should model them because, e.g., these are part of the curriculum or they correspond to the ethical responsibilities they perceive they have. This can be regarded as what could be modeled in theory. In practice, there may be reasons for not modeling something, for wanting to but not seeing oneself able to do so, for not being aware of the possibilities because one simply has not reflected on role modeling in that way or at all.

Our exploratory study described in Paper V shows what computing educators with different lengths of teaching experience think that they show to their students in terms of types of care, some emotions, and professional competencies. They also shared reasons why they do this (or not) and in which situations.

An educator may show, as in the examples in the survey, confusion when live-coding: the educator makes it salient to the students when the educator makes a mistake, cannot immediately find what is wrong with the code, etc. One argument for this is to show that this is part of the process, for the programmer to apply different strategies towards solving the problem; it can also be a way to reduce the distance between the educator as all-knowledgeable

and the students. Other educators prefer to avoid showing confusion, connecting it to a lack of preparation and how students may perceive this negatively, especially if the educator is early in their career, such as teaching assistants. Paper V contains more examples with this and other emotions, such as pride when the code works versus pride as an emotion to avoid, frustration shown towards technology but not towards students, etc. Systemic and cultural barriers are to be considered too, for example, looking at which emotions are seen as socially accepted (and for whom) in different specific contexts.

When describing care (for oneself as well-being practices, for other humans such as students, colleagues, family, or users, for other living and non-living beings, and for the planet), knowledge is another point to raise. Does the educator think they know how to include care in their teaching? Whether they know or not, the educator may think care is not relevant in nor connected to their teaching or simply something private not to be shared in a professional context. As with emotions, it is essential to think about who is allowed to be caring in which contexts.

Educators can also model intrapersonal and interpersonal dispositions. For instance, the survey participants refer to flexibility, continuous learning, integrity, social responsibility, and other examples of intrapersonal dispositions, while examples of interpersonal ones are communication, readiness to help, fairness, and humility. Other types of role modeling include, e.g., experience in industry and/or academia (“Too few teachers actually have experience of working as an engineer or with engineers, outside the academia. I can give examples that few other teachers can.”), and aspects not exclusive to professional life, showing that the educator also has a personal life (perceived “as a complete person - both invested in my professional life and having a life outside work.”).

For all kinds of role modeling, our theoretical reflections may lead to tensions in practice. For example, modeling being my unique self, subjectification, may sometimes not be compatible with caring for my colleagues or students. This is very much exemplified by Robin’s example in the interviews where she refuses to help a colleague both to avoid perpetuating gender norms through her role modeling but also for her own sake:

[...] a PhD student being mistreated [and I am asked] to help this student while getting no credits for that, and I say ‘I won’t do that’. I like this student, so it’s bad for this person that I’m not helping but it is extremely important in principle that I don’t. And I do not want to show to [others] that ‘Oh, you know, I just do things for no credit’, so this is important. [...] I like this person, I would like to be nice to this person, but I can’t because it means I would do things that I shouldn’t do. And this is partly to protect myself but it’s also important to send the signal that this is not OK.

Balance and consideration of one’s circumstances are required to reflect on how to address these tensions in the particular case of each educator.

As approaches that involve emotions [101, 80] and care [122, 112] are lacking in engineering, it is crucial to study how educators think they can show how they care and for whom, the emotions they experience, and the dispositions connected to these. These are examples of role modeling that can be hindered by norms and systemic barriers, examples that help us understand what obstacles to tackle and what scaffolding we can encourage to support role modeling in a context. In the next section, I continue this line of thinking by considering educators as professionals embodying disciplinary and professional identities and how context matters in how this role modeling is perceived.

5.2.7 A matter of context and disciplinary identities: who is a role model in practice?

When discussing role modeling in computing and engineering, it is worth considering who can be seen as such depending on whether they are perceived as “in” the discipline or not. This dichotomy, aiming to simplify our thinking, can backfire and leave options out. For example, is someone who studied computing but currently works at a bank a person “in computing” that we could consider as a role model? Is a student taking a programming course as part of their physics degree a student “in computing” that could make use of role models in the discipline (or outside of it)? Paper II gives broad examples where both the role model and the emulator can be seen as someone “in” or “out” the discipline. Overall, the framework presented in this thesis aims to advocate for a broader definition of what being part of computing and engineering as a potential role model (or emulator) is, to encourage discussions that have a less rigid definition of what it means to be a professional, student, etc. in these disciplines.

In his interview, Joe thinks about how he thinks that students perceive some of the teachers they meet in their studies:

I have been talking to the students a lot more than in the past, getting in the lab [...]. [I] kept this feeling that they hold [another teacher] and I in a bit of awe, programming gods. I’m one of the first programming teachers they see and [the other teacher] is the one who teaches the really hardcore stuff, you know, C.

This is an example of how students may look up to their teachers and value certain kinds of competencies as they see these as connected to the discipline, e.g., competencies connected to programming. The goal can become to be recognized as a “programming god”. When these competencies seem to be missing, it can affect whether a teacher is perceived as a positive role model. In Paper III, we use the example of a Human-Computer Interaction (HCI) teacher and how he is perceived by a third-year student, from Anne-Kathrin

Peters's Ph.D project [110]. This teacher is in the same context as Joe. The student says:

The teacher [of the HCI course] was very interested in HCI. [...] We thought: 'He is not a real computer scientist!'. (laughs) But then it turned out that he actually could program and that he was as good as we are, [...] just that he had an interest for that which was a bit fuzzy.

In Paper III, we use identity theory to argue for the influence of context in these perceptions, particularly when actors in role modeling have different levels of power and their ways of being and participating in the discipline are valued differently. We connect research on identity and on traditions in the history of computing to talk about what it means to be a person in computing as something socially constructed and negotiated in social interaction and power relations, thinking about the consequences for individual behavior and learning. As in the examples above, not all disciplinary identities may lead to a teacher (or other people in computing and engineering) being recognized as "a real computer scientist" [110] and thus considered a positive role model. Instead, teachers who embody identities perceived as illegitimate may be regarded as negative role models. This means that social contexts can constrain who gets to be a positive role model in computing and engineering education.

5.2.8 A definition: what is a role model?

In her interview, Robin talks about guest lecturers and how the definition of role model changes for her if inspiration is part of it:

[...] you might argue that they [guest lecturers] are role models but I'm not sure that they are really. To me it feels that if guest lecturers are an example of role models that's... isn't that a bit conflated with inspiration? Or is it the same thing?

The literature on role modeling has different definitions of the term (as detailed in Chapter 2). Some incorporate factors like similarity to the role model, as Gibson's definition [42]. Others focus on the motivation effect for the students with the role model, such as Gladstone and Cimpian's definition [45]. There is also work on defining terms close or somewhat overlapping with role model, such as mentor or hero. In Paper II, I summarized the differences from different angles. Role modeling does not imply an interaction between the role model and the emulator, as opposed to a mentor interacting with their mentee. In role modeling, the emulator wants to become like the role model in some way, as opposed to considering a hero that we may admire but not want to imitate, or a mentor that helps us develop in a way that may not necessarily match the mentor's characteristics.

Considering these and other definitions and considerations (as detailed in Paper II), besides my own work, I have used several definitions of role model in the papers in this thesis:

- In Paper I, we write that “being a role model as a teacher can be experienced as the teacher’s embodiment of their own experience of certain traits, skills, or qualities, with the potential result of students attempting to imitate this selected behavior.” This definition does not explicitly include negative role modeling (in terms of avoiding becoming what the role model represents), but it does include the possibility of modeling something that others would consider detrimental to the emulator. It is also very focused on behavior.
- In Paper II, I define “role model in engineering as a person who embodies a seemingly attainable achievement and/or an aspect (competency, character attribute, or behaviour) which, through its imitation or avoidance, may help another individual achieve a goal.” This is the definition used in Papers IV and V as well. This definition incorporates the dimensions of what can be modeled according to my framework (achievements or aspects) and is more explicitly about negative role modeling.
- In Paper III a “role model in computing is an individual who embodies one or more desirable ways of engaging with the discipline and/or profession.” It is a specific case of the definition from Paper II. It presumes that the individual’s goal is to be recognized as part of the discipline or profession and that a set of achievements and aspects led to this recognition and are represented by the role model. For negative role modeling, “desirable” would be “undesirable”.

The overarching definition would then be the one used for Papers II, IV, and V. It can be adapted for specific cases and contexts, such as in Paper III. While the definition mentions achievement and/or aspect in singular, a role model may, of course, model more than one achievement or aspect.

6. Practical implications: examples of making use of this work as a practitioner

This chapter contains different examples of how the framework for role modeling can be used in various practical ways ¹. One approach is to consider an individual's role modeling for a certain context. For example, in my role as an educator in computing, what do I model for my students? Another approach is to think about what kind of role modeling we would like to see in a particular context, to then look for various individuals who could -collectively - represent these different kinds of role modeling. For example, if we want to organize an event with role models of marginalized genders, what do we want to be represented? Certain achievements, character attributes,...? Organizers of the event can use the framework for these discussions. Finally, it is also possible to make use of the framework to reflect on what aspects and achievements are emulated by a certain group. For example, what is it that a group of students see as worth imitating in the context of engineering?

6.1 Setting for the examples

In order to illustrate these different approaches, I will use the fictional example of Raine. They are an academic at a Swedish university where they are in charge of teaching project courses. In these courses, groups of students work together to develop a product, gaining skills in preparation for their upcoming individual master theses. A teaching assistant advises each student group, and Raine does the general lecturing, course coordination, and final assessment.

Raine has an educational background in computer science from a South African university (including a Ph.D. in Human-Machine Interaction). Before becoming an assistant professor at the Swedish university several years ago, Raine worked in industry in Canada for a few years as a user experience designer. All of Raine's professional life has included volunteering for Sustain IT, an international non-profit organization advocating for sustainability in computing. In this work, Raine met their current romantic partners, Apoorva and Fernando. Both Apoorva and Fernando are computer scientists. Apoorva is an academic in the same research area as Raine; she finds her discussions with Raine on research and teaching matters really enjoyable.

¹My including in this thesis content targeted at practitioners is very much inspired by Robin Salmuelsson's example when writing his Ph.D. work [128, 129].

Fernando prefers to avoid discussing anything work-related with Raine; he prefers instead to focus on their shared interests, such as bouldering, painting, and sewing.

The example of Raine is not based on any real person I know. I have simply thought of a person that would show kinds of role modeling and reflections on them that I find relevant (or that others in sessions I led, such as [46, 50, 49], seemed to deem important) to share with practitioners interested in using my framework. When appropriate, I have clarified where some of the inspiration for a particular example came from. For instance, part of my imagining Raine as a volunteer comes from my own experience as one (see Chapter 4, thinking of role models for an event [47], but this was not on sustainability).

6.2 Reflecting on an individual's role modeling

In some instances, we may want to reflect on what a particular person is able to model by themselves. This means only considering said person and not who else in the same context could also be a role model, e.g., we focus on what an educator can model themselves and not what other educators in the same course could contribute with their own role modeling.

What an individual can role model includes both what the person can model now and what they might be able to model in the future. What a person currently models can be divided into 1) what the person is already aware of modeling at the moment and 2) what the person is unaware they are modeling but others can perceive. What the person could potentially model but has not done so (so far) refers to achievements and aspects that the person already has but could be made more salient to others. I have included two examples below of how these different approaches to reflecting on an individual's role modeling can be approached in the case of an educator in computing and when the role model is a student in engineering.

6.2.1 Example: reflecting as an educator

Raine attended a session on role modeling as an educator, where they learned about how educators can be role models for their students. Raine wants to reflect more on how this applies to their particular context, so they are happy to go through the material given in the workshop. It includes the following writing prompt: “What achievement and aspects can you role model for your students, so that they can emulate these?” Raine carefully considers this and then writes their initial thoughts in no particular order:

- I want to show my students that programming skills are important in computing, but so are teamwork skills: most projects are not a one-person effort, and working in a team requires more than each person working individually and then putting their work together.

- I also think being a competent communicator is important. It is crucial to know how to spread the word about our work!
- I try to be a kind person, fair (in my own interpretation of fairness).
- When I like a project, I can be quite enthusiastic, although I am usually a relatively calm person.
- I want to show my students that I can be proud of who I am but humble enough to admit when I am wrong.
- I think it is important both for local and international students to see an immigrant as an assistant professor.

Raine can then identify different types of what can be modeled (highlighted in bold font):

- I want to show my students that **programming skills** are important in computing, but so are **teamwork skills**: most projects are not a one-person effort, and working in a team requires more than each person working individually and then putting their work together.
- I also think being a **competent communicator** is important. It is crucial to know how to spread the word about our work!
- I try to be a **kind** person, **fair** (in my own interpretation of fairness).
- When I like a project I can be quite **enthusiastic**; although I am usually a relatively **calm** person.
- I want to show my students that I can be **proud** of who I am but **humble** enough to admit when I am wrong.
- I think it is important both for local and international students to see an **immigrant who is successful as an assistant professor**.

Raine's thoughts can be presented in a table representing the *what* part of the framework, as shown in Table 6.1. When considering skills, Raine realized that their teaching allows them to embody programming skills (for example, when they show their own code to the students and it includes good practices); however, there are no opportunities to show teamwork skills through Raine's own example. Nevertheless, Raine can have an attitude or behave in ways that transmit their belief on the importance of teamwork skills, e.g., praising collaboration examples among the students, referring positively to how the inclusion of collaboration dispositions in the learning outcomes for the course. Presentation skills are an example of both, where Raine can embody these while also transmitting to students a belief in their relevance.

Looking at the table, Raine realizes that they have focused primarily on character attributes, and could perhaps think more about achievements. They add to their table that they have a list of publications (objective achievement) that students interested in that research area could check and perhaps want to try to achieve for themselves. Raine also makes a note to refer to the years of industry work as a user experience designer (objective achievement) when applicable, e.g., in Raine's institutional profile and/or presentation to the students at the beginning of the course. Raine hopes this helps students see their teacher

Achievement		Aspect		
Objective	Subjective	Competency	Character attribute	Attitude/behavior
Immigrant Assistant Professor	Successful Immigrant Assistant Professor	Programming skills	Kind	Teamwork skills are important
		Presentation skills	Fair	Presentation skills are important
			Calm	Enthusiastic
			Proud of oneself	
		Humble		

Table 6.1. Example of individual reflection on an educator’s role modeling (the case of Raine)

Achievement		Aspect		
Objective	Subjective	Competency	Character attribute	Attitude/behavior
Immigrant Assistant Professor	Successful Immigrant Assistant Professor	Programming skills	Kind	Teamwork skills are important
		Publications	Experienced user experience designer	Presentation skills
Calm	Enthusiastic			
Proud of oneself				
Hired for years as user experience designer				Humble

Table 6.2. Example of updated individual reflection on an educator’s role modeling (the case of Raine)

also as a user experience designer who is experienced (subjective achievement).

The updated table (Table 6.2) represents the role modeling of which Raine is aware to different extents. Reflecting on, for example, how to make some achievements more salient to the students has in turn increased Raine’s awareness of this part of their role modeling. As for intention, Raine:

1. wants all students to emulate some aspects, such as certain skills and believing in their importance;
2. wants some - but not all - students to have the option to emulate other aspects and achievements, such as students interested in an academic career could be inspired by Raine's academic position while students interested in industry may look more at Raine's industry experience;
3. does not have a particular intention for other aspects to be emulated, such as being a calm person, as Raine thinks this is a personal choice and diversity in ways of being is to be expected and celebrated.

Once Raine has developed an understanding of what they are aware of modeling and what they can intentionally model, one possible next step is to consider other sources of input that can complement this reflection. Raine considers having a conversation with several people:

1. Sanne, a colleague who has taught with Raine in the past and who Raine thinks would be comfortable giving them honest feedback,
2. Hidhir, a teaching assistant who is part of the teaching team in Raine's current course,
3. Apoorva, who can have a nuanced perspective on role modeling connected to Raine's research profile, as they are in the same area,
4. Fernando, who is not in the same research area as Raine and thus may have a different view on what to emphasize in a project course,
5. One or more of the students in Raine's current course.

Raine approaches their colleague Sanne, and an agreement is made: they will give feedback on each other's role modeling as an educator. Sanne writes down some aspects and achievements that Raine had already identified. But she also adds new ones, such as maintaining a good work-life balance and having impressive intercultural competencies.

Raine decides that there would be a power imbalance if they asked a teaching assistant. Hidhir may not feel safe expressing an honest opinion for fear, for example, of negative consequences. A realization follows: being a teacher implies being a potential role model not only for the students but also for the teaching assistants and the rest of the teaching team. They may emulate the teacher, especially if formal pedagogical training has not been provided. Raine makes a note to reflect on this different approach to role modeling after completing their reflection on the students as emulators.

A similar power imbalance would apply to asking a student for their feedback. Since it does not seem like a good idea for Raine to approach one student, Raine aims instead to use the lens of role modeling when looking at course evaluations, reports from student representatives, and other sources of student input.

When Raine asks Apoorva, she highlights, among other things, that Raine has a broad network with many different kinds of contacts and how Raine has made use of this in their professional life. For example, Raine has been part of multidisciplinary projects. She also reminds Raine of how helpful it was for

her to observe Raine showing frustration, and how to deal with it, in different professional situations.

Fernando shares how much it has helped his mental health to maintain the pleasant routine of bouldering with Raine, who is the one encouraging him to go even when he is feeling less motivated. He also thanks Raine for being so attentive and receptive to his needs when they discuss; he is sure that Raine has a similar attitude towards their students and colleagues. Finally, Fernando reminds them of Raine's passionate efforts in Sustain IT, and how both voluntary work and the particulars of doing so as a way of caring for the planet can inspire students.

After gathering all this feedback, Raine reflects again on several points of what they have been told that they model:

- which achievements they can add to their reflection table, including those not explicitly mentioned in their teaching, such as experience in voluntary work, multidisciplinary projects, etc.
- which emotions they have displayed (perhaps through behavior or as a display of a character attribute), as Apoorva mentioned frustration, Raine thought of enthusiasm, and Fernando highlighted passion.
- what Raine is interested in and cares about, which gets noticeable through their achievements and aspects. For example, Raine was told about their care for students, colleagues, and the planet, and now realizes that care for the users is another example in this theme that is noticeable through, for example, Raine's behavior.

Raine has now a good picture of what they are currently modeling and what they can make more salient to the students. Now Raine wonders: how are they as an educator deciding what they should be modeling? Raine decides to consider three different approaches:

1. Thinking of values and virtues: this is how Raine was brought up and therefore this seems quite intuitive. For example, Raine had no problems including virtues such as fairness, humility, etc. in their initial reflections. But Raine saw that this approach did not cover other kinds of role modeling that other people highlighted, so they want other options for reflection.
2. Thinking of care: Raine thinks of their relationships, who and what they care about, and how they aim to address what they need. Another realization: Raine also cares for themselves, for example by prioritizing bouldering with Fernando.
3. Thinking of norms, of conforming to systems and expectations from others: Raine thinks about being part of different communities and assimilating some of their ways of acting, thinking, and being, and how sometimes Raine goes against these. For example, as an asexual person, Raine defies social conventions of what romantic relationships are expected to include; as a sustainability advocate, Raine encounters a lot

of resistance when challenging, for example, how much their colleagues fly to scientific gatherings instead of taking the train.

These approaches help Raine extend their list of what to model. However, Raine encounters some difficulties when thinking about how to model some of these aspects and achievements.

One kind of difficulty is connected to potential negative consequences. It is scary to model in a salient way being someone who does not fit norms. How would others (management, students, colleagues,...) take this? Would it affect evaluations or opportunities for collaboration or jobs? For their sexual orientation, Raine does not see a way to make this salient during teaching. They can mention their partners, which some students may see as role modeling polyamorous relationships. But what can be done to model asexuality in a way that Raine feels comfortable with? Raine decides to put the asexual flag as a sticker on their laptop as a subtle sign that some students may recognize and others might try to find out about. Raine thinks then about their mental illness and whether they want to be very open about it. They decide to go back to this reflection in the future. For now, they can make their well-being practices, rather than their diagnosis or struggles, more salient. As mentioned, these are hobbies and socializing such as bouldering in good company, painting and sewing, and ways to maintain a work-life balance, like no work on the weekends. Raine adds to the slide deck for introducing their course that neither the teaching team nor the students are expected to respond to emails during off hours and thinks of other ways of modeling this. They also mention their hobbies in their university profile.

Another kind of difficulty is related to a lack of knowledge and/or confidence. Raine wants to be an example of a professional who stops to think about ethical considerations for their work. However, Raine does not feel as well equipped as they would like to role model this in their teaching. To some extent, they can, but they feel that they are indeed not an expert and can miss many important points that need to be made. Raine decides to take a course on teaching ethics and, in the meantime, invites guest lecturers to the class that can be this kind of role model for the students.

This makes Raine realize another challenge: what if some kinds of role modeling are somewhat contradictory? Raine wants to invest more time and energy in caring for others, for example, by following through when Student A repeatedly missed assignments and class or when Colleague B was mistreated at a meeting. But Raine also knows that their own energy levels are low, and caring for others to this extent would mean having even fewer resources to care for Raine themselves. This leads to a reflection on how it is impossible for Raine always to model everything they would like to model and how decisions that are difficult must be made according to different circumstances.

Raine notices that, so far, they have mainly reflected on what they model that can be something beneficial (or neutral) for the students to imitate. But Raine knows that they can also transmit more questionable attitudes, etc. While

Raine does want to think about this to grow as a professional and as a person overall, they also recognize how challenging this kind of thinking can be for one's mental health. Raine makes a note to start small, listing a couple of aspects they would like to work on (like their, at times, impatience when students seem to "not get it") and considering having similar conversations as above, with room for gentle constructive criticism at a level matching Raine's energy levels.

Finally, after following all these steps, Raine believes that they have a good understanding of how complex role modeling is and that reflecting on it is a long and sometimes draining process. Raine decides to be kind to themselves and take this process (or the parts Raine feels comfortable with) in several rounds, with support from others, and considering how their context affects what is possible at the moment.

This example shows a very thorough and time-consuming process to reflect on one's role modeling. Here I want to emphasize that I do not expect educators to be able to do this in a short period of time, nor necessarily follow all of these steps or in this order. Rather, I tried to give an example as complete as possible and leave it to the reader to decide what is most useful and feasible for them.

6.2.2 Example: reflecting as a student

Raine has an assignment for their students: each student is to write an individual reflection. Students are prompted to think about how they as students in the course can be role models for others in the class. After gathering the reflections, Raine can give individual feedback to each student, encouraging them to think about the kinds of role modeling that are missing from their reflections. For example, Student A writes about being a negative role model for lack of industry experience (as opposed to Students B and C and other students who have worked in different companies before starting this study program). Student A also mentions that he can model how to make sure to take breaks from work, for example, because he organizes meet-ups for a knitting group once a month. Raine can then encourage Student A to reflect on how being an organizer requires some competencies that indeed apply to the course, especially in terms of teamwork (the importance of which Raine is trying to model themselves, as seen in the example above). Raine hopes that this exercise helps students feel more confident about what they bring to the table while it gives Raine an idea of what students value and what they expect to do and learn in the course. In this sense, this is similar to the example in Subsection 6.3.2 on students thinking about who their role models in engineering are. Raine decides it is best not to explore negative role modeling with the students, as this may lead to anxiety and/or unpleasant experiences.

This example is inspired by my experience teaching students new to the Swedish higher education system, where the student cohort tends to comprise students with diverse backgrounds in terms of educational background, work experience, geographical culture, etc.

6.3 Reflecting on kinds of role modeling in a context

Rather than reflecting on what one person can model, a different approach is to consider what kind of role modeling would be desirable or is already happening in one particular context. Here I give two examples of this. First, how conference organizers discuss how they envision role modeling at their event. While this example is in a conference setting, a similar process could be followed for, among other cases, planning role modeling for a study program. The second example in this section is about how students reflect on who their role models in technology are.

6.3.1 Example: kinds of role models in a conference

As a volunteer at Sustain IT, Raine is one of the organizers of SIT (Sustainability in Information Technology). SIT is an event where speakers with different backgrounds and positions (such as activists and/or researchers) encourage people to “sit” and discuss issues related to sustainability and technology. Participants can have all levels of knowledge about these topics, including none. Raine is part of the team that will select the speakers after a call for participation (CFP) is distributed. This selection team is trying something new: they will take several steps to think about what kinds of role modeling they want to see represented by the speakers at SIT. For this, they follow similar steps as they read in a research publication [48] (see Related Work RIX).

First, the team decides to include a question about role modeling in their CFP. When a potential speaker submits their application for a presentation, the candidate has to include not only the title and summary of the talk but also a short reflection on what they think can be role models for the participants in the event. The instructions for applying include examples of role modeling, such as having an educational background outside of technology degrees and/or a confident attitude. With these examples, the team of organizers aims to support the candidates in thinking of different kinds of role modeling (according to the role modeling framework), to hopefully avoid the candidates focusing only on achievements or aspects of a certain type.

While waiting for the candidates to submit their applications, Raine’s teammates decide to continue by individually reflecting on the ideal role modeling they would like to see at the event. Raine creates a similar table as they did when reflecting in Subsection 6.2.1. In Raine’s view, an ideal candidate transmits kindness and is skillful in creating a space for dialogue (as many difficult

conversations can take place). The candidate can talk about topics connected to the impact of technology on the planet, such as energy consumption and what can be done to reduce it (considering the event's participants not only as producers but also consumers of technology). After a while, Raine compiles a list of aspects and achievements that they think are important to have represented at SIT by the speakers they will select.

Once all the selection team members have done their individual reflections, they have a group meeting. The agenda is to see how, when putting all the individual reflections together, some parts may overlap while others may be contradictory. Raine sees, for example, that another team member had listed knowledge of work on social sustainability as important. Raine agrees with this and is happy that someone else has thought of something Raine had missed in their reflection. A different team member has written that speakers must have a certain level of experience, and a discussion ensues. Some members argue that early career professionals and students can have fascinating points to make and that SIT should make space for these kinds of voices too. Eventually, the team goes through all the kinds of role modeling presented by each team member and reaches an agreement on what they are looking for in SIT speaker candidates. They call this the "ideal role modeling", and it helps them make more concrete the vision they have for the event.

The next step for the group is to compare their "ideal role modeling" to the "potential role modeling", the different kinds of role modeling that the speaker candidates claim that they can represent. Luckily for the organizing team, there is 1) some overlap between what they were hoping for and what some candidates aim to role model, and 2) there are even more interesting kinds of role modeling as described by some candidates that the organizing team had not thought of. This helps the team expand their vision of role modeling at the event. They can now choose the final list of speakers for SIT.

Raine suggests that the participants' view is also fundamental. In particular, Raine suggests having a question in the event registration about what kinds of role modeling the participants expect to have at the event. For the feedback form sent to participants after the event, Raine suggests a similar question, this time about the kinds of role modeling that the participants think did happen at SIT. Which individuals at the event did they consider role models and why? Raine refers to this last question as asking for "actual role modeling".

The team can now compare the ideal, potential, and actual role modeling that they compiled about this year's SIT. They can then discuss how this affects their vision for the event. Raine also suggests developing personas (a common practice in Human-Machine Interaction): fictional profiles of people that serve as examples of who could be a, for example, speaker or participant at SIT. For instance, they could develop a persona that shows certain aspects and achievements that a student could have and could role model at next year's SIT.

This example is inspired by my experience: by how we approached role modeling when organizing an event in Spain to celebrate women in computing [47]. While unfortunately, the next edition of the event had to be canceled due to the COVID-19 pandemic, we could still follow part of the process described in this publication [48].

6.3.2 Example: students' role models

Raine tries a different exercise with their students. It is based on a classroom assessment technique called “profiles of admirable individuals” [4]. The assignment is an individual reflection on who each student's role models are when they think about engineering. The students need to explain not only who their role models are but how and why. These questions, especially the last one, help both Raine and the students to understand better what they consider important as a person in engineering, what they value, and how this may differ from what others in the same classroom value [4].

Raine uses the framework for role modeling to encourage further reflections on aspects and/or achievements that are missing from the submissions. For example, if a student focused on how a famous person had a high status, respect from others, and a good salary, then Raine would ask the student about competencies, or character attributes that the student could also see in that person. Raine finds that this exercise can have different results depending on whether students are at the beginning or end of their study programs, as their view of what engineering is develops throughout the years [108].

This example is based on Adrian Ross's project for his bachelor thesis [124], where I acted as supervisor. Ross gave students at a Swedish high school a questionnaire prompting students to think about who their role models in technology were. He then used my framework for role modeling to categorize and discuss the types of role modeling found as a result.

The example is also connected to a similar thought by Alex, one of the teachers I interviewed in Sweden, who wishes for this kind of reflection to take place not only for a course but in broader contexts:

It would be, for other courses or areas [in the department where we work], it would be nice to know, being a role model is very connected to who would you like to be in the future, so if your role model is a startuper, putting some idea without putting it together and then selling it, making a lot of money, or if your role model is someone who opened a big foundation, or if your role model is Snowden, or someone who actually got out of the... That could be important or relevant, to understand what we are doing here, what kind of people are going out of our courses independently of whether we thought of that beforehand or not *laugh*

Alex reflects on how describing who our role models are is a way of making more concrete what we value in a professional, or as part of the profession.

It can help us understand better what the students' goals are, and whether their expectations match what they will encounter in their education and future professional life. He also highlights that this is can be later in their studies, to understand the outcome of going through their education.

7. Contributions

In this chapter, I first summarize what my findings imply and contribute to the computing and engineering education communities (specifically but not exclusively). I describe this in terms of contributions to both research and practice. In particular, how I addressed the research questions, developing a framework that can be used as a theoretical lens, while the same framework (as seen in the examples in Chapter 6) can scaffold practical reflections and discussions on role modeling.

In Section 1.3 I introduced the overarching researching question ORQ:

How can role modeling in computing and engineering education be conceptualized, as seen from the role model's perspective?

In Chapter 5, I described both the framework and the findings from other publications in this thesis that support the framework. This is how I addressed ORQ from different angles. The conceptualization of role modeling includes questions such as what is role modeling, who is part of it, what can be modeled in theory and in practice, how aware and intentional this modeling is, why to role model what aspects and achievements, and how context plays a role in all of this.

7.1 Expanding how we understand and discuss role modeling

In terms of what role modeling is, my work expands the everyday view of role modeling as “a person who someone admires and whose behaviour they try to copy” [22]. Role models are not only the representation of something extraordinary in a positive way. They can be examples of what to imitate or what to avoid becoming. My work includes terms for role modeling that allow for more nuanced discussions than simply evaluating role modeling as positive or negative; in popular discourse, “good” or “bad” role models. The implied admiration in the dictionary definition can sometimes lead to a thought: role models are only those worthy of admiration and, since I do not see myself as such, I cannot be a role model. The dimensions of *awareness* and *intention* in my framework, and the realization of how role modeling is not always planned or about an exceptional characteristic of the role model, can help educators and others think about what they may be transmitting to individuals around them. Defined in a broader way than in the dictionary, role modeling in this thesis comprises that which is salient and possible to emulate, rather than just

behavior. That is, everyone is a potential role model whether they want it or not, whether they are aware of it or not, whether they are “good” examples or not of not only behavior but also other aspects and achievements.

Overall I have provided a definition of role modeling that can be used at different levels of abstraction (as detailed in Subsection 5.2.8): from generally focusing on achievements and aspects connected to a general goal to more concrete cases such as representations of disciplinary identities that help achieve the goal of being recognized by oneself and others.

Within ORQ, I posed two research questions in the particular case of educators as role models and students as observers (in the framework, emulators):

- RQ1: What can educators in computing and engineering role model?
- RQ2: What are obstacles that affect what is role modeled by educators in computing and engineering?

7.2 What educators can model

The framework described in Chapter 5 shows what educators (and others in computing and engineering) can model (RQ1). This is divided in two: what is externally given to the role model or *achievements* (objective and subjective), and what is inherent to the role model or *aspects* (competency, character attribute, attitude or behavior). When the educator thinks of achievements and aspects of their own role modeling this may refer to two situations. First, to what they are currently modeling. In Paper V we show examples of educators showing care, emotions, and related professional competencies. Second, to what they could potentially model. To help educators plan for what they want to model, for them to have a way of considering what is important to model as an educator, in Paper IV we describe how to make use of three different ethical theories applied to role modeling in engineering education. Educators can think about how they model 1) virtues and vices (from virtue ethics), represented mainly as character attributes in the framework, 2) caring for someone or something, such as for students, colleagues, users, devices, and the planet, manifested in aspects and achievements from the framework, and 3) being their unique selves. Besides the examples in Chapter 6, I include some pointers for general reflections in this area below.

RQ1 can also be interpreted as what educators are actually able to model considering their circumstances, among other factors. To explore this, the findings from the exploratory study described in Paper V show different kinds of role modeling that educators themselves perceive that they are doing for their students. In particular, these findings throw light on care, emotions, and professional competencies that are lacking in the contexts of computing and engineering education [122, 80, 81]. Thus, educators may perceive the feasibility of this kind of role modeling as more limited than, for instance, the feasibility of modeling what is clearly stated in the curriculum, such as pro-

gramming competencies. Similarly, as shown in Paper III, while educators may be able to role model different kinds of disciplinary identities, this role modeling is not necessarily perceived as positive. It can also be negative role modeling, an example of what the students aim to avoid becoming. When we connect research in identity with traditions in computing, and how this in turn is transmitted through role modeling, we contribute to work advocating for educators to be more aware of the history of the discipline and how they embody their position in this sense [139]. The reflection on identity and context challenges views of effective role modeling as simple exposure, that a student being exposed to a potential role model surely will have that person as a positive role model. Our work shows that context matters and can become an obstacle to positive role modeling.

7.3 Obstacles to role modeling

Considering that context matters and is a potential obstacle for role modeling is indeed very connected to RQ2, on barriers and obstacles to role modeling as an educator. In Paper V we include different reasons and situations for educators not to model something, from their perspective. Educators can see emotions and care, among other perspectives, as something that does not belong in the educational environment, as something they simply do not know how to incorporate into their teaching or that would have negative consequences for them if they did.

Another kind of obstacle to educators' role modeling is the tension(s) between ethical theories when using their various lenses. The tensions can appear within the use of one theory, as the example in Chapter 6 shows: caring for others sometimes clashes with caring for oneself, and the educator needs to decide how to solve this conflict. Tensions can also appear between different theories. For instance, an educator's view on fairness, on being a fair teacher, may collide with what the educator perceives that a particular student needs. Should fairness or the student's needs be prioritized?

One way of solving these conflicts is to realize that role modeling, while a personal reflection, is not necessarily an individual effort. The framework provides a way for groups to discuss role modeling in a context (see examples in Chapter 6), a way where many bear the responsibility of modeling rather than all being carried individually, without connection, on one person's shoulders.

These reflections and discussions can be done individually or in groups.

7.4 Reflection prompts

The work in this thesis leads to reflection prompts, as an individual or as a group, for the context being studied (as similarly outlined in Paper IV for teachers in engineering) such as:

- What should be modeled in this context?
- What should be modeled in this context in terms of emotions and professional competencies?
- What should be modeled in this context in terms of virtues, care, and subjectification (being one's unique self)?
- How is the potential role model (such as an educator) modeling the above?
- Who, other than the potential role model above, could complement that role modeling? This would be done by modeling that which the potential role model cannot or simply does not want to model.
- What are barriers and obstacles to role modeling? Which of these are systemic?
- How can the barriers and obstacles for role modeling be addressed, by the potential role model and/or others with (more) power?

These reflections, while done individually, can also be discussed in groups, or used in other ways in pedagogical training, study program design, etc.

The framework offers a way of reflecting on and discussing role modeling from the perspective of the role model, as opposed to previous work where the focus is on the perspective of the ones emulating them, such as the impact on the students [45]. While I emphasize educators as role models for their students, this thesis and the publications it connects contain examples of role models who are instead other professionals, students, or someone who is not professionally active in the discipline, such as a relative with a different profession.

7.5 Expanding what we role model outside of norms

The work in this thesis can also be seen as a call to action to make more prominent what we role model outside of norms, by summarizing some of the points made above. In Paper V, we show examples of how care, emotions, and related professional competencies can be modeled by educators, besides bringing attention to reasons why and in what situations this is (not) possible. In Paper III, we expand this to achievements and aspects connected to disciplinary and professional identities that do not fit what the students perceive as legitimate. The framework described in Paper II is designed to lift that which is not exclusively knowledge and skills, such as character attributes, attitudes, and behaviors, to show their importance and facilitate reflections on how we can make these more salient and intentional as part of role modeling in CER and EER.

Overall, the framework and the findings in this thesis that support it can be a tool to reflect on and discuss the kinds of role modeling that take place in our contexts, the kinds that should and could happen, and what our role in making this positive change can be depending on our position within these contexts.

8. Future work

As role modeling is such a complex phenomenon, there are numerous options for future work. The most apparent options are connected to the continuation of the work presented in the papers connected in this thesis. Other options are inspired by these publications but may not necessarily follow up on that work.

The research on identity that is presented in Paper III could be complemented with more research in this area, more specifically in computing but also from other disciplines in STEM. In Chapter 2 I have exemplified this by connecting Carlone and Johnson's framework for identity with role modeling in computing and engineering. In particular, identity theory can be used to explore the role of role modeling in who is included and who is excluded (and why) in these disciplines.

The theories in Paper IV could be complemented with argumentation that uses ethical theories such as consequentialism and deontology. Consequentialist theories could be used, for example, to decide between two different kinds of role modeling depending on the consequences for different individuals and/or groups. A deontological approach would put more focus on, for example, the codes of ethics from organizations that professionals (and, sometimes, students) agree to follow, and the connection to what is role modeled as a result.

As Paper V describes an exploratory study, it follows that the work is to be continued. Without the timeline and space restrictions, we could develop the presentation of the connections between the categories in our findings. Ethical approval for the collection of sensitive data would allow us to investigate the connection between social identities and the situations in which and reasons why an educator may or may not show certain emotions, types of care, and professional competencies. The list of emotions can be expanded, and more focus can be put on negative emotions, such as anxiety or shame. Overall, there are many opportunities to investigate in more detail, for example by zooming in on role modeling of well-being practices, which is currently lacking in research on emotions [81].

Both maintain the focus on educators as role models and the idea of zooming in on specific contexts, I am working with Emma Riese on teaching assistants (TAs) as role models. As opposed to more experienced educators, TAs are often not given pedagogical training [118, 117, 116] but are more in contact with the students and are perceived as more approachable [119, 116, 120]. All of these factors show that it is important to look at the particular case of TAs' role modeling, and my framework can be used to analyze it as a way to gain a better understanding of this phenomenon.

Other examples of more concrete cases of role modeling by educators in computing and engineering are connected to particular contexts, e.g., role modeling as a teacher in introductory programming courses. As the framework can be used for role models other than educators, other examples include role modeling by students, professionals, relatives, etc.

Most of the framework is designed considering the role model and the educator (except for cases such as an endorsed role model or using the framework to discuss role modeling in a context, where it is a third party who is judging the role modeling). Third-party perspectives can be further explored, for example, by studying the perspectives of program coordinators or managers with the power to affect role modeling in their contexts.

More data can be collected and analyzed to refine the framework further. Most prominently, the student perspective on educators' role modeling, e.g., looking for similarities and differences between what the educator thinks they model and what their students actually consider as role modeling by their teacher. Further data can be collected from educators from other institutions and that broadens the range of identities represented in my original set of interviews. This can be complemented by revisiting said interviews with a different approach. One can explore, for example, the role of time, such as whether the role model intends for students to emulate something now and/or further in their careers.

Besides my continuing with data collection and using the framework in other settings, future work includes others using the framework in their research and/or practice.

Overall, role modeling is present in many aspects of computing and engineering education, and thus, there are many avenues for future work. Ideally, this would be done in multidisciplinary teams, such as with psychologists who contribute with theories on motivation and interest, sociologists who study norms in the disciplines, etc.

9. Concluding remarks

Conducting the work for this thesis was an exercise in vulnerability for me, as it was to write it. I do not think it is possible to think about your role modeling without reflecting on what you believe in, what and who you care about and for, what you want to transmit, what you feel you are incapable of or prevented from modeling, and many other questions. All these reflections come as an always ongoing process, since the answers depend on when and where we are, with whom we share spaces, and what our and their positions in these spaces are. Taking the time and energy to have an honest conversation with yourself about all of this can be overwhelming and draining. For some, it may be easy to focus on a rising feeling of inadequacy, the intense spotlight on all those achievements and aspects that we think we are missing in ourselves. At times, it has been for me. Perhaps we think of all of our positions as educators, researchers, academics in general, students, parents, tutors, caregivers of humans and other beings, professionals of any kind, and the many situations in which we seem to be very noticeable but far from feeling ready to be observed, let alone emulated. It can be very uncomfortable to feel scrutinized, particularly when we are not feeling that confident or even good enough.

And yet, here I am writing a whole thesis to gently and kindly invite others to do the same exercise I have done. To look inside and see what we can achieve through our role modeling, through giving the spotlight and supporting others who tend to be silenced and excluded. Because thinking about ourselves as potential role models can be indeed challenging, but it can also give us so much: a feeling of hope, of empowerment, a sense of direction, some purpose. It can be the realization that what we show about ourselves, however consciously that may be, can bring something positive to others. We are capable of making positive change just by displaying our achievements and aspects in a way that others can use.

How do we make that change? Everyday language is full of idioms that refer to the importance of role modeling as something perceivable, as something that can be then copied or avoided. “You can’t be what you can’t see”, advocating for prominent examples that inspire people similar in some way to the role model. “Do as I say, not as I do”, as those who care for children are painfully aware of; we need to not only “talk the talk” but also “walk the walk”. Similar idioms can be found in other languages. Overall, we need to remember that role modeling is about communicating not just through words but through ways of being and doing that other people can notice.

Role modeling is not just about imitation. We can also be examples of what the observer should avoid so that they achieve their goals. This is not necessarily a negative outcome. We can, for example, show students how much writing is part of being a researcher, how much (some of us) enjoy it, and how we are continuously developing our competence in this regard. This may lead to some students being more motivated than before to become academics, others may emulate the writing competencies for professions outside academia, and yet others may see this as another reason to avoid research work, having the goal of an occupation that does not require so much time and effort on an activity they do not enjoy. In the last case, our example contributed to why a student did not pursue, for instance, a Ph.D. degree. But the career path they eventually chose was a much better fit for them. Thus, that we represented what they avoided did have a positive outcome.

In other instances, unfortunately, we may indeed contribute to students perceiving themselves as someone who does not fit and/or is not welcome in our disciplines. We may represent narrow views of computing and engineering, of a reduced set of what ways of being and doing are seen as valid in these spaces. Someone wisely advised me once that, to break norms, we first need to know how they work. We also know that those who fit norms tend to be oblivious to them. So we need to improve our understanding of norms in our disciplines and then reflect on how our role modeling can broaden who and what is seen as legitimate in our spaces. In this thesis, I have given several examples of this. For instance, by including argumentation on role modeling connected to identity and traditions in computing in Paper III and how some educators display different emotions and care outside of computing norms in Paper V. I have also highlighted how being our unique selves, as the result of using ethics of freedom (further described in Paper IV and exemplified in Chapter 6), can guide our steps towards us role modeling outside of norms that do not match our authentic selves.

Role modeling of knowledge and skills can be the intuitive approach: we look at the curriculum and learning outcomes and aim to transmit through our example how to achieve them. But, when we teach, we transmit much more than that. Some learning outcomes already include dispositions, such as enthusiastically applying skills. Enthusiasm, passion, confusion, frustration, anxiety... It is the example of emotions that raises another question. How do we role model that which we have not been trained for, that which may already be difficult for us? We may, perhaps, believe that it is important to show our students how we care for the planet, yet we may not know how to do this, or we may feel more lost when it comes to showing our anxiety and how we handle it. We do not need to do this alone.

Role modeling should not be an individual but a collective effort. While I advocate for individual reflections on our individual role modeling, there are others around us who should be part of this process. As educators, we may feel like we are not able to model everything that our students need. This is

only realistic: one person cannot possibly represent all the different aspects and achievements that can help a diverse set of students with various identities and interests achieve their different goals. Rather than one role model that embodies everything, students can instead have many different role models that represent numerous aspects and achievements. As educators, we take pedagogical courses, and these could include aspects of role modeling; we work with colleagues who may be willing to give us feedback on our role modeling¹ (as exemplified in Chapter 6); we are part of a system with people in different power positions, individuals who can make decisions on who and what is more prominently noticeable by the students at various stages of their study programs. Discussion on role modeling should not be limited to individual educators but rather permeate to all levels of the education system.

As described in Paper IV and shown as examples in Chapter 6, ethical theories give us different ways of thinking about what we should role model as educators. Our team chose to focus on three. The importance of thinking about virtues, considering relationships and addressing the needs of those we care about, and being our unique selves. While I have expressed these in different ways in this chapter, I want to emphasize care again, as it is personally meaningful to me.

A person with one or more marginalized identities may experience role modeling differently from others who represent the norm(s). Being from a marginalized group may lead to being more noticeable, and thus more clearly expected to be an endorsed role model; there may be more pressure to be a positive one as a way of representing the whole community as opposed to being seen simply as an individual. A simple illustration of this phenomenon that comes to mind is from the comic strip *xkcd*. Person A judges how another person seems to be bad at math. When the person evaluated is male-presenting, the evaluation is “Wow, you are bad at math.”, whereas the female-presenting person gets evaluated with a “Wow, girls are bad at math.”². This thesis is not simply about the women who are “good at math” as role models for girls and women, as the kind of example easy to find in the media and as important as that is. This thesis is, instead, a call to action for all of us in education, to do our part as role models to broaden participation in our disciplines, regardless of our identities. To refrain from putting on marginalized individuals the unrealistic expectation of doing all the role modeling; to, depending on our position, promote both caring for others and for ourselves, and do so as a community. The worrisome state of mental health for both academics and students is just one of the reasons why we need to prioritize caring perspectives on education.

¹This may be a good chance to wonder whether we need to wait for a colleague to ask us about their role modeling or we can directly, without prompt, tell them what we notice about them that we think should be emulated by others (or that we aim to emulate ourselves).

²See comic strip at <https://xkcd.com/385/>

The framework I describe in this thesis is my approach to making something as complex as role modeling become something more accessible in terms of reflection. I hope it sends the message that, in so many different ways, we are all bringing something to the table. Something that students and others can notice and emulate (or avoid) to their benefit and, as a consequence, to the benefit of others around them. So many diverse “somethings” that we as educators can transmit, regardless of how confident about them we may feel inside. I want to encourage us all to think about our role modeling and to be kind to ourselves and others when we do so. And, with that, a summary as a call to action and final affirmation as educators:

We matter. You matter.

Virginia Grande
Uppsala, April 2023

10. Summary in Swedish (Sammanfattning på svenska)

Rollmodell (eller förebild) är en term som används i vardagsspråket och i litteraturen om utbildning, särskilt när det gäller mångfald, jämlikhet, inkludering och tillgång. Teermen används när man beskriver aspekter som motivation och inspiration. Men förebild som begrepp förstås och används på olika sätt, eftersom det är löst definierat. Det är därför viktigt att ha ett gemensamt "språk" och struktur för att möjliggöra nyanserade reflektioner och diskussioner kring frågor om vem eller vad som är en förebild, samt hur och varför någon är, eller kan vara, en förebild.

Eftersom vi alla är i situationer där vi kan observeras, är vi alla potentiellt förebilder. I vissa roller är vi mer synbara och har mer makt. En sådan roll är en lärare. Min doktorandavhandling bidrar till en ökad förståelse av hur lärare uppfattar sin egen förebild (detta beskrivs i Paper I) och bygger upp nyanserade reflektioner och diskussioner som bidrar till att lärare vidgar sina vyer på sin roll som förebild. En sådan förståelse kan underlättas genom att använda ett ramverk för att ha ett gemensamt "språk" och struktur.

Förutom hur lärare representerar kunskap och färdigheter, vilket är ett starkt fokus i datautbildning (såsom programmeringsfärdigheter), har min ambition varit att fördjupa mig i hur lärare ser på sin roll som rollmodell och sina prestationer. Detta är något som saknas i tidigare forskning kring att vara lärare i ämnena datavetenskap och teknik. Detta inkluderar sätt att vara och delta i ämnena som inte är fokuserat på det tekniska, logiska och rationella. Detta inkluderar till exempel att vara rollmodell för hur man praktiserar datavetenskap med omsorg och känsla.

Lärare intervjuades och svaren analyserades med metoder som fenomenografi, tematisk kodningsanalys, argumentation, deskriptiv statistik och gruppjämförelser.

Denna avhandling beskriver utvecklingen av ett ramverk för rollmodellering inom data- och ingenjörsutbildning, med tonvikt på förebildens perspektiv. Detta perspektiv är viktigt, eftersom forskning om rollmodellering tenderar att fokusera på perspektivet hos den person som i stället efterliknar förebilden, till exempel när man studerar effekterna av rollmodellering. Ramverket kan användas för olika aktörer inom data- och ingenjörsutbildning, men det är särskilt användbart för lärare i sin roll som förebilder för studenter. Jag fokuserar i avhandlingen på lärare på universitetsnivå.

Ramverket (som beskrivs i Paper II) inkluderar dimensionerna medvetenhet och avsikt med rollmodellering. Alla lärare är potentiella förebilder, och

det är så vare sig de är medvetna om att de är förebilder eller om de avser att de ska efterliknas. Dessa två dimensioner kan kombineras. Vi kan reflektera över hur vi är medvetna om att vara en förebild för något som vi vill att studenterna ska imitera, till exempel god praxis i programmering, samtidigt som vi är medvetna om att vi visar en lugn attityd på jobbet men inte har för avsikt att studenterna ska efterlikna det. Kanske får vi höra av andra (som vi inte är medvetna om) att vi utgör rollmodeller för något de imiterar.

Det som kan modelleras presenteras som prestationer (något externt givet till förebilden) och aspekter (något som är inneboende i förebilden). Prestationer kan vara objektiva (fakta), som en utmärkelse eller en professionell position, eller subjektiva (uppfattas olika av olika personer), som att vara framgångsrik eller erfaren. Aspekter kan vara kompetenser (kunskap och färdigheter), karaktärsegenskaper (vad vi ser som en del av vår "kärna", vår identitet), eller attityder/beteenden (hur vi agerar i vissa sammanhang men inte generellt).

Som perspektiv på hur vi kan reflektera över vilka prestationer och aspekter en lärare bör förebilda, tar vi (i Paper IV) med olika aspekter på etik, som dygd, omsorg och frihet. Det betyder att en lärare kan reflektera över vilka dygder de kan förebilda, som att ta hand om någon eller något (identifiera deras behov och kontrollera om dessa har uppfyllts), eller hur de kan vara deras innersta jag.

Sammanhang och normer spelar roll i rollmodellering, till exempel i vem som är en förebild, vilket vi argumenterar för (i Paper III) genom att använda forskning om identitet och datavetenskapens historia. Vi ger exempel (i Paper V) på vad, hur och var lärare kan vara förebilder för omsorg, känslor och professionella kompetenser utanför normerna inom ämnena.

Denna avhandling bidrar till hur vi förstår och diskuterar rollmodellering i forskning och praktik, inklusive vad som kan modelleras och hinder för det. Arbetet inkluderar även praktiska exempel (inklusive reflektionsuppmärksamhet) för hur ramverket kan användas i praktiken av både lärare och andra praktiker.

11. Summary in Spanish (Resumen en español)

El término “referente” (o “modelo a seguir”) se usa habitualmente en el lenguaje cotidiano y en literatura en educación, particularmente cuando se tratan temas relacionados con diversidad, equidad, inclusión y acceso. También puede estar presente cuando se habla de motivación e inspiración. Sin embargo, modelo a seguir como concepto se entiende y se usa de diferentes maneras, ya que a menudo no se ofrece una definición precisa. Esta inexactitud evidencia la necesidad de un vocabulario y una estructura compartidos que faciliten reflexiones y debates atendiendo a distintos matices sobre el quién, qué, cómo y porqué del *role modeling* (aproximadamente traducido como “modelado como referentes”).

Como cualquier persona se encuentra en situaciones donde puede ser observada, todas las personas somos potencialmente referentes. En ciertos roles, se tiene más notoriedad y se adquiere más poder como referente; uno de esos roles es el de docente. En mi trabajo de tesis, busco comprender cómo el profesorado percibe su propia experiencia como referente (como se describe en el Artículo I) y facilitar reflexiones y debates minuciosos que contribuyan a que el profesorado amplíe sus puntos de vista sobre el *role modeling*. Tales reflexiones se pueden apoyar en el uso de un marco para tener un vocabulario y una estructura compartidos.

El profesorado representa conocimiento y habilidades, los cuales reciben mucha atención en informática (como las habilidades de programación). En esta tesis, además de prestar atención a esos factores, pretendo profundizar en cómo el profesorado ve el *role modeling* de logros y de aquellos factores inherentes a la persona, que aparecen definidos como “aspectos”. Este tipo de role modeling constituye un área cuya ausencia en informática e ingeniería ha sido señalada en investigaciones anteriores. Esto incluye el role modeling de formas de ser y participar en las disciplinas que no están enfocadas en lo técnico, lógico y racional, como aspectos y logros relacionados con cuidados y emociones.

Considerando lo anterior, esta tesis presenta el desarrollo de un marco para el modelado de roles en educación en informática e ingeniería, considerando la perspectiva de referentes. Este enfoque es importante, ya que la investigación sobre referentes tiende a centrarse en la perspectiva de la persona que emula al referente, por ejemplo, cuando se estudian los efectos de tener referentes. Si bien el marco se puede utilizar para diferentes actores en educación en

informática e ingeniería, es de particular utilidad para el profesorado como referentes para el alumnado.

Los datos incluidos en esta tesis incluyen entrevistas y una encuesta a docentes. Para el análisis se usó un enfoque fenomenográfico, análisis temático, argumentación, estadísticas descriptivas, y comparaciones de grupos.

El marco (descrito en el Artículo II) incluye las dimensiones de *conciencia e intención* del *role modeling*. Cualquier persona que se dedica a la docencia es susceptible de ser referente. Esto es así independientemente de si somos conscientes de lo que estamos modelando y de si tenemos la intención de que esto sea emulado. En sus posibles combinaciones, estas dos variables dan como resultado tres grupos de *role modeling*. En un primer grupo, se pueden encuadrar los casos en que la persona es consciente de modelar algo como referente y además tiene intención de que su ejemplo sea imitado por quienes la observan. En un segundo grupo, la persona es igualmente consciente de su condición de potencial ejemplo a seguir pero no tienen intención de que eso sea copiado por quienes la rodean. El tercer y último grupo, ya que no es posible tener intención de ser ejemplo a seguir de algo de lo que no se es consciente, agrupa los casos de aquellos aspectos y logros de que la persona no es consciente de ser ejemplo ni tiene intención de que se la imite pero no por ello dejan de servir como referente.

Lo que se puede modelar se presenta como *logros* (algo dado externamente a quien es referente) y *aspectos* (algo inherente a la persona referente). Los logros pueden ser objetivos (hechos), como un premio o una posición profesional, o subjetivos (entendidos de manera diferente por diferentes personas), como tener éxito o experiencia. Los aspectos pueden ser competencias (conocimiento y habilidades), atributos de carácter (lo que vemos como parte de nuestra identidad “central”) o actitudes/comportamientos (cómo actuamos en ciertos contextos pero no en general).

Como lentes para reflexionar sobre qué logros y aspectos debe modelar quien se dedica a la docencia, se presentan (en el Artículo IV) tres enfoques éticos: la ética de la virtud, la ética del cuidado (*care ethics*, en inglés), y la ética de la libertad. Esto significa que el profesorado puede reflexionar sobre qué virtudes puede modelar, sobre el cuidado de alguien o de algo (identificando sus necesidades y comprobando si han sido satisfechas), o sobre cómo mantenerse fieles a quienes son, en su ser insustituible.

El contexto y las normas son importantes en el *role modeling*, por ejemplo en cuanto a quiénes son referentes, como se argumenta (en el Artículo III) utilizando investigaciones sobre identidad e historia de la informática. Se presentan ejemplos (en el Artículo V) del qué, cómo y dónde del *role modeling* del profesorado sobre cuidados, emociones y competencias profesionales fuera de las normas en las disciplinas.

En esta tesis, busco expandir el cómo entendemos y discutimos el modelado de roles en la investigación y la práctica, incluido lo que se puede modelar y los obstáculos para ello. Se aportan ejemplos prácticos (incluidas indicaciones

para promover reflexiones) sobre cómo usar el marco tanto con docentes como con otros tipos de profesionales.

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There were too many times during my Ph.D. when I thought I wouldn't be able to do it. Because I did not have the energy, because I felt that I did not belong in academia, or academia was not a space for me, because... Well, because I felt like there was so much going on, so much to work on, and so little energy that it was hard to picture myself graduating. Both in the challenging and easier times, I was always surrounded by a network of support and love; an immense privilege. A diverse group of people, of role models, that kindly showed me other perspectives, that taught me how to extend grace to myself and others, people whose examples helped me grow as a professional and/or a person. I would not have managed to reach this milestone without them.

I am thankful for the many people in my life who have accompanied me during this Ph.D. journey and shared their kindness, vulnerability, advice, and a long list of other examples that I very much appreciate. While I have really tried to include all of you here, I am sure that I have not been able to truly capture why each of you should be mentioned here nor have I probably succeeded in writing about every person that should be a part of this acknowledgements¹. Still, here goes my attempt to celebrate you!

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¹If you are in this latter group, I promise to treat you to a hot beverage of your choice while you listen "live" to all the reasons why I appreciate you!

words and example, to explore that path. That drive, that energy to make computing and engineering spaces where more ways of being and participating are welcome and celebrated is so contagious. With Anne, I am constantly reminded that being an academic and an activist are not incompatible endeavors. To do that, one needs to be the “killjoy” so often, which few people want to do and which I find very draining. But I gain my energy and my drive back every time I see Anne fighting to make the world a fairer and more sustainable place. And this is something I see every time I interact with her. Anne, thank you for always reminding me through your example not to give up, learning and drawing from very different communities, while you also make space for me to experience all kinds of emotions and be kind to myself in the process. You have such an important positive impact in every space you are part of.

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Katerina Günter makes look easy something that I find rare in academic spaces. She fosters environments where a lot of time and effort goes to celebrate people. She works hard to ensure that a wide diversity of competence is valued (and highly) and that everyone in the group feels seen, being their most authentic selves. In short, Katerina transmits this warmth that clearly signals that there is no pressure to perform as anything; rather, one is gently invited to just be, simply as one is, and this will be celebrated. I have experienced all of this not only as a researcher but through, for example, being supported when I started transitioning. She role models vulnerability, care, and appreciation often and in different ways. Katerina's example gives me hope for academia.

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Nelly Marosi is one of the wiser people I know, and I owe her so very much. She is an example of how doing research where humans are involved can be doing research with and for people. Nelly is an inspiration for constantly learning how to be more inclusive in so many ways. She does so by listening (really listening), by advocating for others and gently but firmly helping us realize when we need to check our bias and privilege. Nelly has been a crucial part of my learning to accept and celebrate myself. She's on a mission to change the world and, when you see that in action, it's impossible not to want to be on her team!

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Outside of work

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One of my favorite ways to disconnect from everything, enjoy a good book, and discuss that or anything related to parenting, is our International Parents Book Club gatherings. Thank you, *Asma*, for creating this fantastic initiative, and for being such an easy-going person, always with something interesting, funny and/or kind to say. It was great to be able to meet people like *Sofia* and *Erin* (who has the coolest thesis topic ever!).

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²I mean, Martin is an excellent player and always succeeds in his first attempt!

³I am not using capitals to indicate yelling. Rather, it is because Elena and Diego are at an age where they can recognize their names in uppercase. This way, I can show them (already at the time of this writing) that they were included in “el libro de mamá”, mom’s book :)

References

- [1] Janet N Ahn, Danfei Hu, and Melissa Vega. “Do as I do, not as I say”: Using social learning theory to unpack the impact of role models on students’ outcomes in education. *Social and Personality Psychology Compass*, 14(2):e12517, 2020.
- [2] The All European Academies (ALLEA). The European Code of Conduct for Research Integrity. <https://www.allea.org/wp-content/uploads/2017/05/ALLEA-European-Code-of-Conduct-for-Research-Integrity-2017.pdf>. Last accessed: 2023-04-14.
- [3] Amnah Alshahrani, Isla Ross, and Murray I Wood. Using social cognitive career theory to understand why students choose to study computer science. In *Proceedings of the 2018 ACM conference on international computing education research*, pages 205–214, 2018.
- [4] T Angelo and K Cross. *Classroom Assessment Techniques*. Jossey-Bass, 1993.
- [5] Aristotle. *Nicomachean ethics (T. Irwin Trans.)*. Indianapolis, IN: Hackett Publishing, 1985.
- [6] ACM Association for Computing Machinery. Curricula recommendations. <https://www.acm.org/education/curricula-recommendations>. Last accessed: 2023-02-03.
- [7] Maria Giulia Ballatore, Linda Barman, Jelle De Borger, Julia Ehlermann, Robbie Fryers, Kevin Kelly, Julia Misiewicz, Ida Naimi-Akbar, and Anita Tabacco. Increasing gender diversity in STEM: A tool for raising awareness of the engineering profession. In *Proceedings of the Seventh International Conference on Technological Ecosystems for Enhancing Multiculturality, TEEM’19*, page 216–222, New York, NY, USA, 2019. Association for Computing Machinery.
- [8] Albert Bandura. Social foundations of thought and action. *Englewood Cliffs, NJ*, 1986(23-28), 1986.
- [9] Albert Bandura. *Self-efficacy: the exercise of control*. Freeman, 1997.
- [10] Albert Bandura. Social cognitive theory: An agentic perspective. *Annual review of psychology*, 52(1):1–26, 2001.
- [11] Kacey Beddoes. Examining privilege in engineering socialization through the stories of newcomer engineers. *Engineering Studies*, 13(2):158–179, 2021.
- [12] Anders Berglund. *Learning computer systems in a distributed project course: The what, why, how and where*. PhD thesis, Acta Universitatis Upsaliensis, 2005.
- [13] Gert Biesta. What is education for? On good education, teacher judgement, and educational professionalism. *European Journal of Education*, 50(1):75–87, 2015.
- [14] Gert Biesta. Risking ourselves in education: qualification, socialization, and subjectification revisited. *Educational Theory*, 70(1):89–104, 2020.

- [15] Jonathan Black, Paul Curzon, Chrystie Mykietiak, and Peter W McOwan. A study in engaging female students in computer science using role models. In *Proceedings of the 16th annual joint conference on Innovation and Technology in Computer Science Education*, pages 63–67. ACM, 2011.
- [16] Sarah Jane Bork and Joi-Lynn Mondisa. Engineering graduate students’ mental health: A scoping literature review. *Journal of Engineering Education*, 111(3):665–702, 2022.
- [17] Jonas Boustedt. *On the road to a software profession: Students’ experiences of concepts and thresholds*. PhD thesis, Acta Universitatis Upsaliensis, 2010.
- [18] Virginia Braun and Victoria Clarke. Using thematic analysis in psychology. *Qualitative research in psychology*, 3(2):77–101, 2006.
- [19] Eric Bredo. Philosophies of educational research. In *Handbook of complementary methods in education research*, pages 3–31. Routledge, 2012.
- [20] Patricia Bricheno and Mary Thornton. Role model, hero or champion? Children’s views concerning role models. *Educational research*, 49(4):383–396, 2007.
- [21] Dictionary Cambridge English. Competency. <https://dictionary.cambridge.org/dictionary/english/competency>. Last accessed: 2023-04-14.
- [22] Dictionary Cambridge English. Role model. <https://dictionary.cambridge.org/dictionary/english/role-model>. Last accessed: 2023-04-10.
- [23] Heidi B Carlone and Angela Johnson. Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, 44(8):1187–1218, 2007.
- [24] Brandon I Collier-Reed, Åke Ingerman, and Anders Berglund. Reflections on trustworthiness in phenomenographic research: Recognising purpose, context and change in the process of research. *Education as change*, 13(2):339–355, 2009.
- [25] Hilde G. Corneliussen, Gilda Seddighi, and Carol A. Dralega. *Women’s Experience of Role Models in IT: Landmark women, substitutes and supporters*, pages 375–395. Universitetsforlaget, 2019.
- [26] The Swedish Research Council. Ethics. <https://www.vr.se/english/mandates/ethics.html>. Last accessed: 2023-04-14.
- [27] The Swedish Research Council. Ethics in research. <https://www.vr.se/english/mandates/ethics/ethics-in-research.html>. Last accessed: 2023-04-14.
- [28] Sofie Craps, Maarten Pinxten, Heidi Knipprath, and Greet Langie. Different roles, different demands. a competency-based professional roles model for early career engineers, validated in industry and higher education. *European Journal of Engineering Education*, 47(1):144–163, 2022.
- [29] Mats Daniels, Anders Berglund, and Arnold Pears. A case study: the Uppsala Computing Education Research Group (UpCERG). In *Past, Present and Future of Computing Education Research: A Global Perspective*. Springer, 2023.

- [30] Mats Daniels, Lauri Malmi, Arnold Pears, and Simon. What is Computing Education Research (CER)? In *Past, Present and Future of Computing Education Research: A Global Perspective*. Springer, 2023.
- [31] Anna T Danielsson, Heather King, Spela Godec, and Anne-Sofie Nyström. The identity turn in science education research: a critical review of methodologies in a consolidating field. *Cultural Studies of Science Education*, pages 1–60, 2023.
- [32] Anna Eckerdal. *Novice programming students' learning of concepts and practise*. PhD thesis, Acta Universitatis Upsaliensis, 2009.
- [33] Elina Eriksson, Anne-Kathrin Peters, Daniel Pargman, Bjorn Hedin, Minna Laurell-Thorslund, and Sandra Sjöo. Addressing Students' Eco-anxiety when Teaching Sustainability in Higher Education. In *2022 International Conference on ICT for Sustainability (ICT4S)*, pages 88–98, Plovdiv, Bulgaria, June 2022. IEEE.
- [34] Berenice Fisher and Joan Tronto. Toward a feminist theory of caring. *Circles of care: Work and identity in women's lives*, pages 35–62, 1990.
- [35] ACM (Association for Computing Machinery). ACM Code of Ethics. <https://www.acm.org/about-acm/acm-code-of-ethics-and-professional-conduct>. Last accessed: 2023-04-14.
- [36] Stephen Frezza, Tony Clear, and Alison Clear. Unpacking dispositions in the CC2020 computing curriculum overview report. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–8. IEEE, 2020.
- [37] Batya Friedman. A course in professional responsibility for computer scientists. In *Proceedings of the Conference on Computers and the Quality of Life, CQL '90*, page 174–179, New York, NY, USA, 1990. Association for Computing Machinery.
- [38] MD Gall, WR Borg, and JP Gall. *Educational research*. Longman Publishers, 1996.
- [39] M Garcia. Positionality. In *Encyclopedia of Diversity and Social Justice*, pages 568–569. Rowman, 2014.
- [40] James Paul Gee. *An introduction to discourse analysis: Theory and method*. Routledge, 1999.
- [41] James Paul Gee. Identity as an analytic lens for research in education. *Review of research in education*, 25(1):99–125, 2000.
- [42] Donald E Gibson. Developing the professional self-concept: Role model construals in early, middle, and late career stages. *Organization Science*, 14(5):591–610, 2003.
- [43] Donald E Gibson. Role models in career development: New directions for theory and research. *Journal of Vocational Behavior*, 65(1):134–156, 2004.
- [44] Carol Gilligan. *In a different voice: Psychological theory and women's development*. Harvard University Press, 1982.
- [45] Jessica R Gladstone and Andrei Cimpian. Which role models are effective for which students? A systematic review and four recommendations for maximizing the effectiveness of role models in STEM. *International journal of STEM education*, 8(1):1–20, 2021.
- [46] Virginia Grande, Bedour Alshaigy, Anne-Kathrin Peters, and Mats Daniels.

- Who is a role model? An open discussion on the role of role modeling in engineering education. In *2022 IEEE Frontiers in Education Conference (FIE)*, pages 1–4. IEEE, 2022.
- [47] Virginia Grande, Clara Benac Earle, Cristina Manresa-Yee, Elena Gómez-Martínez, Laura M Castro, Patricia Pons, and Raúl Corobán. Everybody rock your equity: Experiences of organizing a women in computing event with role models for diversity and inclusion. In *Digital Transformation for a Sustainable Society in the 21st Century: 13E 2019 IFIP WG 6.11 International Workshops, Trondheim, Norway, September 18–20, 2019, Revised Selected Papers 18*, pages 5–16. Springer, 2020.
- [48] Virginia Grande and Mats Daniels. Who should we invite? A proposal of steps for conference organizers to follow to bring diverse role models to computing events. In *International Conference on Learning and Teaching in Computing and Engineering (LaTiCE), December 12, 2020*. IEEE Computer Society, 2020.
- [49] Virginia Grande, Mats Daniels, and Anne-Kathrin Peters. Types of Role Models for the Frontiers in Education (FIE) Community. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–2. IEEE, 2020.
- [50] Virginia Grande, Anne-Kathrin Peters, and Mats Daniels. Reflecting on your role modeling with a scientific approach. In *World Engineering Education Forum/Global Engineering Deans Council*, 2021.
- [51] Virginia Grande and Kristina Von Hausswolff. “Mature” to doubt: Using ethical theories for role modeling in computing education. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–9. IEEE, 2020.
- [52] Egon G Guba and Yvonna S Lincoln. Epistemological and methodological bases of naturalistic inquiry. *Ectj*, 30(4):233–252, 1982.
- [53] Katerina Pia Günter. *Figuring worlds; imagining paths: A feminist exploration of identities in higher education biology*. PhD thesis, Acta Universitatis Upsaliensis, 2022.
- [54] Katerina Pia Günter, Ingrid Ahnesjö, and Annica Gullberg. “I try to encourage my students to think, read, and talk science” intelligible identities in university teachers’ Figured Worlds of Higher Education Biology. *Journal of Research in Science Teaching*, 2022.
- [55] Oskar Hagvall Svensson, Tom Adawi, and Anders Johansson. Authenticity work in higher education learning environments: a double-edged sword? *Higher Education*, 84(1):67–84, 2022.
- [56] Cynthia Hampton, David Reeping, and Desen Sevi Ozkan. Positionality statements in engineering education research: A look at the hand that guides the methodological tools. *Studies in Engineering Education*, 1(2), 2021.
- [57] Andrew Herod. Reflections on interviewing foreign elites: praxis, positionality, validity, and the cult of the insider. *Geoforum*, 30(4):313–327, 1999.
- [58] Andrew Gary Darwin Holmes. Researcher positionality—a consideration of its influence and place in qualitative research—a new researcher guide. *Shanlax International Journal of Education*, 8(4):1–10, 2020.
- [59] IEEE. IEEE Code of Ethics.
<http://www.ieee.org/about/corporate/governance/p7-8.html>.

Last accessed: 2023-04-14.

- [60] Tsuyoshi Kano, Abdul Matin Sheikh, and Kentaro Toyama. Bimodal IT Career Aspirations in Bangladesh. In *Proceedings of the Tenth International Conference on Information and Communication Technologies and Development, ICTD '19*, New York, NY, USA, 2019. Association for Computing Machinery.
- [61] Amanpreet Kapoor and Christina Gardner-McCune. Categorizing research on identity in undergraduate computing education. In *Proceedings of the 22nd Koli Calling International Conference on Computing Education Research, Koli Calling '22*, New York, NY, USA, 2022. Association for Computing Machinery.
- [62] Päivi Kinnunen. Dealing with emotions—engineering teachers' observations of students' emotional reactions to receiving feedback on their work. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–5. IEEE, 2020.
- [63] Päivi Kinnunen, Robert McCartney, Laurie Murphy, and Lynda Thomas. Through the eyes of instructors: a phenomenographic investigation of student success. In *Proceedings of the third international workshop on Computing education research*, pages 61–72, 2007.
- [64] Päivi Kinnunen and Beth Simon. Phenomenography and grounded theory as research methods in computing education research field. *Computer Science Education*, 22(2):199–218, 2012.
- [65] Paul R Kleinginna Jr and Anne M Kleinginna. A categorized list of emotion definitions, with suggestions for a consensual definition. *Motivation and emotion*, 5(4):345–379, 1981.
- [66] Amy J Ko, Steve Draper, Joseph Maguire, John Pajunen, Matti Tedre, Jane Sinclair, and Claudia Szabo. A dialog about the special issues on theory. *ACM Transactions on Computing Education*, 23(1):1–5, 2023.
- [67] Kristján Kristjánsson. Emulation and the use of role models in moral education. *Journal of Moral Education*, 35(1):37–49, 2006.
- [68] Thom Kunkeler. Inequality in computing education through the lens of social capital: a methodology. In *The United Kingdom and Ireland Computing Education Research (UKICER) Conference*, pages 1–1, 2022.
- [69] Elizabeth K Lawner, Diane M Quinn, Gabriel Camacho, Blair T Johnson, and Bradley Pan-Weisz. Ingroup role models and underrepresented students' performance and interest in STEM: A meta-analysis of lab and field studies. *Social Psychology of Education*, 22:1169–1195, 2019.
- [70] Thomas Taro Lennerfors. *Ethics in engineering*. Studentlitteratur, 2019.
- [71] Robert W Lent, Steven D Brown, Gail Hackett, et al. Social cognitive career theory. *Career choice and development*, 4(1):255–311, 2002.
- [72] Amari N. Lewis, Joe Gibbs Politz, Kristen Vaccaro, and Mia Minnes. Learning about the Experiences of Chicano/Latino Students in a Large Undergraduate CS Program. In *Proceedings of the 27th ACM Conference on on Innovation and Technology in Computer Science Education Vol. 1, ITiCSE '22*, page 165–171, New York, NY, USA, 2022. Association for Computing Machinery.
- [73] Euan D. Lindsay and James R. Morgan. The CSU engineering model: educating student engineers through PBL, WPL and an online, on demand curriculum. *European Journal of Engineering Education*, 46(5):637–661,

- 2021.
- [74] Penelope Lockwood, Christian H Jordan, and Ziva Kunda. Motivation by positive or negative role models: regulatory focus determines who will best inspire us. *Journal of personality and social psychology*, 83(4):854, 2002.
 - [75] Penelope Lockwood and Ziva Kunda. Superstars and me: Predicting the impact of role models on the self. *Journal of personality and social psychology*, 73(1):91, 1997.
 - [76] Penelope Lockwood, Tara C Marshall, and Pamela Sadler. Promoting success or preventing failure: Cultural differences in motivation by positive and negative role models. *Personality and Social Psychology Bulletin*, 31(3):379–392, 2005.
 - [77] Johanna Lönngren, Alberto Bellocchi, Pia Bøgelund, Inês Direito, James Huff, Khairiyah Mohd-Yusof, Homero Murzi, and Roland Tormey. Emotions in engineering education: Preliminary results from a scoping review. In *Proceedings of Research in Engineering Education Symposium & Australasian Association for Engineering Education Conference 2021*, number CONF, 2021.
 - [78] Birgy Lorenz, Kaido Kikkas, and Mart Laanpere. Bottom-up Development of e-Safety Policy for Estonian Schools. In *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance, ICEGOV '11*, page 309–312, New York, NY, USA, 2011. Association for Computing Machinery.
 - [79] Stephanie Lunn and Monique Ross. Methodology matters: Employing phenomenography to investigate experiences in computing fields and the application of theoretical frameworks. In *2021 IEEE Frontiers in Education Conference (FIE)*, pages 1–9. IEEE, 2021.
 - [80] J. Lönngren, A. Bellocchi, M. Berge, P. Bøgelund, I. Direito, N. F. A. Rahman, J. Huff, K. Mohd-Yusof, H. Murzi, and R. Tormey. Emotions in engineering education: A systematic review of the literature. (forthcoming).
 - [81] J. Lönngren, I. Direito, R. Tormey, and J. Huff. Emotions in engineering education. In *International Handbook of Engineering Education*. Routledge, (accepted for publication).
 - [82] Lauri Malmi, Judy Sheard, Roman Bednarik, Juha Helminen, Ari Korhonen, Niko Myller, Juha Sorva, and Ahmad Taherkhani. Characterizing research in computing education: A preliminary analysis of the literature. In *Proceedings of the Sixth international workshop on Computing education research*, pages 3–12, 2010.
 - [83] Lauri Malmi, Judy Sheard, Päivi Kinnunen, and Jane Sinclair. Computing education theories: What are they and how are they used? In *Proceedings of the 2019 ACM Conference on International Computing Education Research*, pages 187–197, 2019.
 - [84] Lauri Malmi, Judy Sheard, Päivi Kinnunen, and Jane Sinclair. Development and use of domain-specific learning theories, models, and instruments in computing education. *ACM Transactions on Computing Education*, 23(1):1–48, 2022.
 - [85] Tabish Manzoor, Waleed Iqbal, Eisha Tir Razia, and Samia Razaq. Bridging educational gaps through volunteers; implementation, problems and their

- solutions. In *Proceedings of the Eighth International Conference on Information and Communication Technologies and Development, ICTD '16*, New York, NY, USA, 2016. Association for Computing Machinery.
- [86] Clare Mariskind. Teachers' care in higher education: contesting gendered constructions. *Gender and Education*, 26(3):306–320, 2014.
- [87] Ference Marton and Shirley Booth. *Learning and awareness*. Routledge, 1997.
- [88] Robert McCartney and Kate Sanders. ITiCSE Working Groups as an Engine for Community-Building. In *Past, Present and Future of Computing Education Research: A Global Perspective*. Springer, 2023.
- [89] Christine M McCullough. *Do role models matter? Exploring the correlates of motivational and imitative role modeling by professionals*. University of Missouri-Columbia, 2013.
- [90] Friederike Mengel, Jan Sauermann, and Ulf Zölitz. Gender Bias in Teaching Evaluations. *Journal of the European Economic Association*, 17(2):535–566, 02 2018.
- [91] Dictionary Merriam-Webster. Competency. <https://www.merriam-webster.com/dictionary/competency>. Last accessed: 2023-04-14.
- [92] Riitta-Leena Metsäpelto, Anna-Maija Poikkeus, Mirva Heikkilä, Jukka Husu, Anu Laine, Kristiina Lappalainen, Marko Lähteenmäki, Mirjamaija Mikkilä-Erdmann, Anu Warinowski, Tuike Iiskala, et al. A multidimensional adapted process model of teaching. *Educational assessment, evaluation and accountability*, pages 1–30, 2022.
- [93] John R. Morelock. A systematic literature review of engineering identity: definitions, factors, and interventions affecting development, and means of measurement. *European Journal of Engineering Education*, 42(6):1240–1262, 2017.
- [94] Thekla Morgenroth, Michelle K Ryan, and Kim Peters. The motivational theory of role modeling: How role models influence role aspirants' goals. *Review of general psychology*, 19(4):465–483, 2015.
- [95] José A Muñoz and Idalis Villanueva. Latino STEM scholars, barriers, and mental health: a review of the literature. *Journal of Hispanic Higher Education*, 21(1):3–16, 2022.
- [96] Greg L Nelson and Amy J Ko. On use of theory in computing education research. In *Proceedings of the 2018 ACM Conference on International Computing Education Research*, pages 31–39, 2018.
- [97] Nel Noddings. *Philosophy of education*, 1995.
- [98] Nel Noddings. The caring relation in teaching. *Oxford review of education*, 38(6):771–781, 2012.
- [99] Sofia Nyström. The dynamics of professional identity formation: Graduates' transitions from higher education to working life. *Vocations and Learning*, 2(1):1–18, 2009.
- [100] Maria Olsson and Sarah E Martiny. Does exposure to counterstereotypical role models influence girls' and women's gender stereotypes and career choices? A review of social psychological research. *Frontiers in psychology*, 9:2264, 2018.
- [101] Andreas Ottemo, Maria Berge, and Eva Silfver. Contextualizing technology: Between gender pluralization and class reproduction. *Science Education*,

- 104(4):693–713, 2020.
- [102] Anita Patrick and Maura Borrego. A review of the literature relevant to engineering identity. In *American Society for Engineering Education Annual Conference*, 2016.
- [103] Arnold Pears, Mats Daniels, and Anders Berglund. Theory and approaches to CER. In *Past, Present and Future of Computing Education Research: A Global Perspective*. Springer, 2023.
- [104] Arnold Pears, Neena Thota, Päivi Kinnunen, and Anders Berglund. Harnessing theory in the service of engineering education research. In *2012 Frontiers in Education Conference Proceedings*, pages 1–5. IEEE, 2012.
- [105] Reinhard Pekrun. Inquiry on emotions in higher education: progress and open problems. *Studies in Higher Education*, 44(10):1806–1811, 2019.
- [106] Reinhard Pekrun, Thomas Goetz, Wolfram Titz, and Raymond P Perry. Academic emotions in students’ self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational psychologist*, 37(2):91–105, 2002.
- [107] Reinhard Pekrun and Lisa Linnenbrink-Garcia. Academic emotions and student engagement. In *Handbook of research on student engagement*, pages 259–282. Springer, 2012.
- [108] Robert T. Pennock and Michael O’Rourke. Developing a scientific virtue-based approach to science ethics training. *Science and Engineering Ethics*, 23(1):243–262, Feb 2017.
- [109] David N Perkins, Eileen Jay, and Shari Tishman. Beyond abilities: A dispositional theory of thinking. *Merrill-Palmer Quarterly (1982-)*, pages 1–21, 1993.
- [110] Anne-Kathrin Peters. *Learning computing at university: Participation and identity: A longitudinal study*. PhD thesis, Acta Universitatis Upsaliensis, 2017.
- [111] Anne-Kathrin Peters. Students’ experience of participation in a discipline – a longitudinal study of computer science and it engineering students. *ACM Transactions on Computing Education (TOCE)*, 19(1):5:1–5:28, September 2018.
- [112] Anne-Kathrin Peters, Stefan Bengtsson, Åsa Cajander, Mats Daniels, Virginia Grande, Johanna Lönngren, and Minna Salminen-Karlsson. Care ethics to develop computing and engineering education for sustainability. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–4. IEEE, 2020.
- [113] Marian Petre, Kate Sanders, Robert McCartney, Marzieh Ahmadzadeh, Cornelia Connolly, Sally Hamouda, Brian Harrington, Jérémie Lumbroso, Joseph Maguire, Lauri Malmi, et al. Mapping the landscape of peer review in computing education research. In *Proceedings of the Working Group Reports on Innovation and Technology in Computer Science Education*, pages 173–209. ACM, 2020.
- [114] Lilian L Pozzer and Phoebe A Jackson. Conceptualizing identity in science education research: Theoretical and methodological issues. *Sociocultural Studies and Implications for Science Education: The experiential and the virtual*, pages 213–230, 2015.
- [115] Rajendra Raj, Mihaela Sabin, John Impagliazzo, David Bowers, Mats Daniels,

- Felienne Hermans, Natalie Kiesler, Amruth N Kumar, Bonnie MacKellar, Renée McCauley, et al. Professional competencies in computing education: Pedagogies and assessment. In *Proceedings of the 2021 Working Group Reports on Innovation and Technology in Computer Science Education*, pages 133–161. 2021.
- [116] Emma Riese. *Perspectives on Assessment in Introductory Computer Science Courses: Exploring and Comparing Experiences of Students, Teaching Assistants, and Course Coordinators*. PhD thesis, KTH Royal Institute of Technology, 2022.
- [117] Emma Riese and Viggo Kann. Training teaching assistants by offering an introductory course. In *Proceedings of the 53rd ACM Technical Symposium on Computer Science Education V. 1*, pages 745–751, 2022.
- [118] Emma Riese, Madeleine Lorås, Martin Ukrop, and Tomáš Effenberger. Challenges Faced by Teaching Assistants in Computer Science Education Across Europe. In *Proceedings of the 26th ACM Conference on Innovation and Technology in Computer Science Education V. 1*, ITiCSE '21, page 547–553, New York, NY, USA, 2021. Association for Computing Machinery.
- [119] Emma Riese and Stefan Stenbom. Experiences of assessment in introductory programming from the perspective of noncomputer science majors. In *2020 IEEE Frontiers in Education Conference (FIE)*, pages 1–9. IEEE, 2020.
- [120] Emma Riese and Stefan Stenbom. Engineering students' experiences of assessment in introductory computer science courses. (Manuscript), 2022.
- [121] Sweden's Riksdag. The Swedish Act (2003:460) concerning the ethical review of research involving humans. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/lag-2003460-om-etikprovning-av-forskning-som_sfs-2003-460. Last accessed: 2023-04-14.
- [122] Donna Riley. Hidden in plain view: Feminists doing engineering ethics, engineers doing feminist ethics. *Science and engineering ethics*, 19:189–206, 2013.
- [123] Colin Robson and Kieran McCartan. *Real World Research*. Wiley, 4th edition edition, 2016.
- [124] Adrian Roos. Who Are Their Role Models? Reflections Of Students, In Grade 1 Upper Secondary School In Sweden, Role Models In Technology. <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-500202>.
- [125] Monique S Ross. Let's have that conversation: How limited epistemological beliefs exacerbates inequities and will continue to be a barrier to broadening participation. *ACM Transactions on Computing Education*, 2022.
- [126] Mihaela Sabin, Hala Alrumaih, John Impagliazzo, Barry Lunt, Ming Zhang, Brenda Byers, William Newhouse, Bill Paterson, Svetlana Peltsverger, Cara Tang, Gerrit van der Veer, and Barbara Viola. Information Technology Curricula 2017 (IT2017). Technical report, ACM/IEEE Computer Society, New York, NY, USA, 2017. <https://dl.acm.org/doi/pdf/10.1145/3173161>.
- [127] Roger Säljö. Talk as data and practice - a critical look at phenomenographic inquiry and the appeal to experience. *Higher education research and development*, 16(2):173–190, 1997.

- [128] Robin Samuelsson. Reasoning with thermal cameras: Framing and meaning-making in naturalistic settings in higher education. Licentiate Thesis, 2020. Uppsala University.
- [129] Robin Samuelsson. *Resourceful students: Engaging students in active and systematic investigations in labs involving thermal phenomena*. PhD thesis, Uppsala University, forthcoming.
- [130] Matilde Sánchez-Peña and Julianna Gesun. Work-in-progress: Exploring the wellness perceptions of engineering and science faculty. In *2022 ASEE Annual Conference & Exposition, 2022*.
- [131] Matilde Sánchez-Peña, Xinrui Rose Xu, Nichole Ramirez, and Nikitha Sambamurthy. Engineering students and professionals living with a mental illness: an exploration of their experiences and challenges. In *2019 IEEE Frontiers in Education Conference (FIE)*, pages 1–5. IEEE, 2019.
- [132] Matilde Luz Sánchez-Peña, Nichole Ramirez, Xinrui Rose Xu, and Douglas B Samuel. Work in progress: Measuring stigma of mental health conditions and its impact in help-seeking behaviors among engineering students. In *2021 ASEE Virtual Annual Conference Content Access, 2021*.
- [133] Dale H Schunk. Peer models and children’s behavioral change. *Review of educational research*, 57(2):149–174, 1987.
- [134] Dale H Schunk. Social cognitive theory. In *APA educational psychology handbook, Vol. 1. Theories, constructs, and critical issues*, pages 101–123. American Psychological Association, 2012.
- [135] Allison Scott, Alexis Martin, Frieda McAlear, and Sonia Koshy. Broadening participation in computing: examining experiences of girls of color. *ACM Inroads*, 8(4):48–52, 2017.
- [136] Stephen Secules, Cassandra McCall, Joel Alejandro Mejia, Chanel Beebe, Adam S Masters, Matilde L. Sánchez-Peña, and Martina Svyantek. Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, 110(1):19–43, 2021.
- [137] BCS (British Computer Society). BCS Code of Ethics. <http://www.bcs.org/category/6030>. Last accessed: 2023-04-14.
- [138] Ella Taylor-Smith, Camilla Barnett, Sally Smith, Matthew Barr, and Carron Shankland. Participant-centred planning framework for effective gender balance activities in tech. In *The United Kingdom and Ireland Computing Education Research (UKICER) Conference, UKICER2022*, page 1–7, New York, NY, USA, Sep 2022. Association for Computing Machinery.
- [139] Matti Tedre. *Science of Computing: shaping a discipline*. Chapman & Hall Book. CRC Press, 1st edition edition, 2017.
- [140] Matti Tedre and Erkki Sutinen. Three traditions of computing: What educators should know. *Computer Science Education*, 18(3):153–170, 2008.
- [141] Karen L Tonso. Engineering identity. *Cambridge handbook of engineering education research*, pages 267–282, 2014.
- [142] Austin Toombs, Shad Gross, Shaowen Bardzell, and Jeffrey Bardzell. From empathy to care: A feminist care ethics perspective on long-term researcher–participant relations. *Interacting with Computers*, 29(1):45–57, 2017.

- [143] Austin L Toombs, Shaowen Bardzell, and Jeffrey Bardzell. The proper care and feeding of hackerspaces: Care ethics and cultures of making. In *Proceedings of the 33rd annual ACM conference on human factors in computing systems*, pages 629–638, 2015.
- [144] Joan C. Tronto. *Moral Boundaries. A Political Argument for an Ethic of Care*. Routledge, 1993.
- [145] Joan C Tronto. Creating caring institutions: Politics, plurality, and purpose. *Ethics and social welfare*, 4(2):158–171, 2010.
- [146] Alex Vakaloudis, Kieran Delaney, Brian Cahill, and Jacqueline Kehoe. Enabling Primary School Teachers to Deliver STEM Programmes with the Internet of Things: Challenges and Recipes for Success. In *Proceedings of the 2019 11th International Conference on Education Technology and Computers, ICETC 2019*, page 80–83, New York, NY, USA, 2019. Association for Computing Machinery.
- [147] Amanda R Van Camp, Patricia N Gilbert, and Laurie T O’Brien. Testing the effects of a role model intervention on women’s STEM outcomes. *Social Psychology of Education*, 22(3):649–671, 2019.
- [148] Carolina de Barros Vidor. *A constituição performativa de identidades na pesquisa em ensino de física : uma perspectiva pós-estruturalista a partir da filosofia política feminista de Judith Butler (The performative constitution of identities in physics education research: a poststructuralist perspective based on Judith Butler’s feminist political philosophy)*. PhD thesis, Programa de Pós-graduação em Ensino de Física. Universidade Federal do Rio Grande do Sul, 2021.
- [149] Idalis Villanueva, Marialuisa Di Stefano, Laura Gelles, Kate Youmans, and Anne Hunt. Development and assessment of a vignette survey instrument to identify responses due to hidden curriculum among engineering students and faculty. *IJEE International Journal of Engineering Education*, 36(5), 2020.
- [150] Idalis Villanueva Alarcón, Joel Alejandro Mejia, Janice Mejia, and Renata Revelo. Latiné, Latinx, Latina, Latino, or Hispanic: Problematizing terms often used in engineering education. *Journal of Engineering Education*, 2022.
- [151] Tina Vrieler and Minna Salminen-Karlsson. A sociocultural perspective on computer science capital and its pedagogical implications in computer science education. *ACM Transactions on Computing Education (TOCE)*, 2021.
- [152] Candace West and Don H Zimmerman. Doing gender. *Gender & society*, 1(2):125–151, 1987.
- [153] Kathryn E Wohlford, John E Lochman, and Tammy D Barry. The relation between chosen role models and the self-esteem of men and women. *Sex Roles*, 50(7-8):575–582, 2004.
- [154] Barry J Zimmerman and Dale H Schunk. Self-regulating intellectual processes and outcomes: A social cognitive perspective. In *Motivation, emotion, and cognition*, pages 337–364. Routledge, 2004.
- [155] Sabrina Zirkel. Is there a place for me? Role models and academic identity among white students and students of color. *Teachers College Record*, 104(2):357–376, 2002.

Appendix A.

Interview guide

Pilot Study: Interviewing Teachers

- Tell me a little about your teaching experience and your involvement in the teaching at the department.
- What is a role model for you? [see different popular definitions and where they make the emphasis.]
- So that everyone I interview has the same definition in mind, let's consider a role model as this: "a person who we see similar to ourselves to some extent, and because of that similarity, we decide to emulate (or avoid) aspects of that person's attributes or behavior. Role models are possible exemplars of the professional skills and personal attributes needed to achieve desired goals (Gibson, 2003)".⁴. What do you think about this definition when you think of your experience?
- It is said that every teacher is a role model for their students. Is this something you have ever reflected on?
- How do you experience the responsibility of being a role model for your students? Is this responsibility limiting your behavior in any way? [if they ask for an example, say that they perhaps don't share personal anecdotes]
- Are you including role models in your teaching? If so, how? In any case, what benefits would you see for your students? And disadvantages?
- What about examples of other students and what they have done?
- Who do you think are your students' role models?
- Some say that we may be steering students in a particular direction by presenting different areas in computing in different ways, e.g., (simplified example) hardware is the "real" part of CS, while software is not as respected. What do you think?
- What do you think could be done at a program level for the inclusion of role models in the teaching in the program? And at a departmental level? [if they ask for an example, say that they perhaps facilitate guest lectures common for various courses or programs like [example at the department]]
- What haven't we discussed that you would like to tell me?

⁴Referring to [42]

Appendix B.

Consent form for interviews

Consent for Participation in Interview Research

I volunteer to participate in a research project conducted by Virginia Grande from Uppsala University. I understand that the project is designed to gather information about teaching practices regarding role models in the IT and DV programs.

1. My participation in this project is voluntary. I may withdraw and discontinue participation at any time without penalty.
2. I understand, if I feel uncomfortable in any way during the interview session, I have the right to decline to answer any question or to end the interview.
3. Participation involves being interviewed by a researcher from Uppsala University. The interview will last approximately 40-60 minutes. Notes will be written during the interview. An audio recording of the interview will be made. If I don't want to be recorded, I will not be able to participate in the study.
4. I understand that the researcher will not identify me by name in any reports using information obtained from this interview, and that standard techniques will be used to prevent a reader from identifying me as a participant.
5. I understand that, under the conditions in 4), the information provided will be part of a discussion with the IT & DV programs coordinators and may be part of a research paper or a similar publication.
6. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
7. I have been given a copy of this consent form.

My Signature

Date

My Printed Name

Signature of the Investigator

For further information, please contact:
Virginia Grande
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