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Figuring Worlds; Imagining Paths

A Feminist Exploration of Identities in Higher Education Biology

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Abstract
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Higher education biology is a natural science discipline that is numerically female biased on undergraduate level across most international contexts. In Sweden, Germany, and the UK, for example, more than 60% of all undergraduate students are women. However, equally prominent in these European contexts and beyond is the progressive decrease in the percentage of women along the academic career ladder, resulting in fewer than 30% of women among full professors in biology. This numerical decline contradicts unproblematised understandings of biology practices as gender-neutral, where biology as a female-coded and "soft" natural science discipline is perceived as free from gendered processes of in- and exclusion. As pointed out by feminist critics of science and science education researchers, gender-neutral discourses hide gendered processes; they unmark, neutralize, and normalize masculinity in natural science practices. Gendered norms in relation to issues of identity and participation in higher education science have been addressed rather extensively in male-dominated natural science disciplines such as physics. However, only a few studies focus these lenses on higher education biology. In this thesis, I explore how university students and teachers negotiate identities, make meaning of emotions, and figure worlds of higher education biology. As a trained biologist and a becoming gender scholar and science educator, I explore biology cultures from in- and outside perspectives. Working from within and between disciplines also provides me with theoretical and methodological tools to understand processes of enculturation in higher education biology, building on an eclectic theoretical framework, combining feminist, social constructivist, and cultural perspectives. I analyse students' study motivation texts and teachers' teaching statements from a Swedish context, as well as interviews with university biology students from three European universities in Sweden, Germany, and the UK. Across the four papers included in this thesis, narrow masculine norms of science, and particularly research, emerge in students' and teachers' identity work. These norms are challenged through alternative and broader imaginaries of biology practice and interpretations of participation within. On the one hand, recognizing broader identities has the potential to widen the practice of higher education biology. On the other hand, students negotiating alternatives to the norm risk not being recognized in interactions with research-focused teachers and hence being hindered in developing a sense of belonging to biology communities. Female students showed a tendency to imagine participation in broader ways, and the clash of this with the normative cultural imaginaries within higher education biology risks contributing to the progressive decrease of the percentage of women in biology at universities. Taken together, this thesis provides further evidence for how higher education biology is far from a gender-neutral natural science discipline. While hegemonic and masculine norms of doing science and research are visible in university biology students' and teachers' identity work, alternative imaginaries provide possibilities for change towards a more diverse field of biology.

Keywords: Biology Education, Communities of Practice, Discourse Analysis, Feminist Science Studies, Figured Worlds, Gender, Higher Education, Science Education, Science Identity

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I believe we could paint a better world
if we learned to see it from all perspectives,
as many perspectives as we possibly could.
Because diversity is strength.
Difference is a teacher.
Fear difference, you learn nothing.

Hannah Gadsby

List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals. Specific contributions are outlined below each individual paper.

I. Günter, K. P., Gullberg, A. & Ahnesjö, I. (2021). "Quite ironic that even I became a natural scientist": Students' imagined identity trajectories in the Figured World of Higher Education Biology. *Science Education*, *105*(5), 837–854.

   I proposed the idea for the project. Ingrid Ahnesjö proposed to use the students' motivation texts as empirical material. Together with Ingrid Ahnesjö, I collected the data. Annica Gullberg proposed figured worlds as a theoretical framework and I developed the framework as used in the paper. Analysis and writing was done collaboratively and led by me.

II. Günter, K. P., Ahnesjö, I. & Gullberg, A. (under review). Intelligible identities in university teachers' figured worlds of higher education biology.

   I proposed the idea for the project. Annica Gullberg and Ingrid Ahnesjö proposed to use the teaching statements as empirical material for the study. Together with Annica Gullberg, I collected the data. I did the qualitative analysis and wrote the paper with feedback from co-authors and Karin S. Lindelöf.

III. Günter, K. P. (in manuscript). Enthusiasms, passions, and interests: Comparing students' and university teachers' meaning making of emotions in higher education biology.

   The idea for a comparative study arose from discussions with Eva Silfver during my 60% seminar. I did the analysis and wrote the paper with feedback from supervisors and others.

IV. Günter, K. P., Bussière, L. & Gromes, R. (submitted). 'Biology must become better at seeing the human beings behind it': University students' identity work across European contexts.

   I proposed the idea for the project and designed the research. I planned and conducted the interviews. I did a preliminary analysis of all interviews and then analysed and discussed the interviews included in the paper together with the co-authors. I wrote the paper with feedback from co-authors and supervisors.

Complementary work

Conference contributions

Günter, K. P., De Barros Vidor, C. & Gullberg, A. (2022). What is the Science when Talking Science Identity? Reflections from a Higher Education Biology Perspective. Accepted as stand-alone paper at NARST 2022—National Association for Research in Science Teaching Conference, 27-30 March, 2022, Vancouver, BC, Canada (hybrid).

Günter, K. P. (2021). Biology Identities versus Nothingness but Becoming a Researcher. Presented in the context of the symposium What is the Science in Science Identity? Discussing Disciplinary Identities at ESERA 2021—European Science Education Research Association Conference, 30 August-3 September, 2021, Braga, Portugal (online).

Günter, K. P. (2019). Nothing More Than That: Students' Motivations Entering Higher Biology Education. Presented as a single paper at ESERA 2019—European Science Education Research Association Conference, 26-30 August, 2019, Bologna, Italy.

Günter, K. P. (2019). You, a Biologist?! Exploring Students' Identity Formation in Higher Biology Education. Presented as a single paper at NORA—Nordic Journal of Feminist and Gender Research, 22-24 May, 2019, Reykjavík, Iceland.

Research article

Ahnesjö, I., Brealey, J. C., Günter, K. P. et al. (2020). Considering Gender-Biased Assumptions in Evolutionary Biology. Evolutionary Biology, 47, 1–5. https://doi.org/10.1007/s11692-020-09492-z.

Contents

Preface

A semicolon indicates a pause. It is a decision of the author to take a breath and then continue. A semicolon is also a decision to connect two pieces of a sentence, pieces of a statement, even though they could have been separated. A semicolon is a decision to continue, even though one could stop. A continuation. Interrupted. To move on, a statement.

When entering new worlds, like the world of higher education biology, we familiarize ourselves with the world's landscapes. We implicitly and explicitly learn about its rules, about the ways we do things in it. We learn about who participates in the world's practices and how participants participate in the world's practices. We learn about and negotiate the world's norms and values. We experience the culture, learn what to know, learn what to do and feel and how. We acquire competences, we negotiate performances and we get recognised based on our competences and performances. Also, we recognise others' competences and performances. We learn in and about cultural worlds, worlds that are historically shaped, their norms and values (re)produced in our social interactions.

As much as worlds are historically, culturally, and socially shaped, we enter these worlds with our histories, our enculturations, and our social shapes. We enter these worlds with ideas about what these worlds look like, who is in them, and where they will bring us, including ideas about our trajectories, our paths. We enter worlds with imaginaries of the very worlds we enter, imaginaries of who we will become in these worlds. Sometimes our experiences, experiencing the world, are in line with our imaginaries. Sometimes our imaginaries change with our experiences along the way. Sometimes our experiences digress, deviate from our imaginaries, expectations, wishes, dreams, digressions; deviations that make us feel like we do not belong, like we unbelong.

It is here a comma is placed, a mark that indicates a deviation, indicating a path that deviates, indicating to deviate. Figuring the world to be different from our imaginaries. Figuring our imaginaries to be different from worlds. Figuring the world to mark our paths. To mark us. Yet, we continue. It is here we could set a full stop. A mark that ends. Figuring the world to end our paths. Or, we pause and decide to continue. We place a semicolon. We continue imagining our paths despite having figured the world.

This thesis explores imaginaries of paths and identities in figured worlds of higher education biology, paths that are imagined as possible or impossible, identities that have been marked and unmarked.

It started as a result of my semicolons. And it started with me quitting. I studied biology because I could not move to the university city that offered a veterinary medicine programme. And I studied biology because I thought physics would be too hard. Then, already in the second biology semester, I quit my studies. I did a voluntary ecological gap year in out-of-school education, met biologists, and returned to university, studying and teaching biology. During my studies in Germany, talking with fellow biology students, I found, like me, they did not call themselves biologists. Then, after moving to Sweden as an exchange student during my master's work, I talked to undergraduate students who called themselves biologists as if it were the most natural thing in the world. Why would they, when I did not? It made me wonder what it means to be a biologist and who wants to and gets to become and be a biologist.

While writing my master's thesis, a PhD position in gender studies with a focus on biology and/or chemistry didactics was announced—an opportunity to start answering these questions. After talking to Anders Johansson about his work and the concept of science identity and after reading Anna Danielsson's thesis, both people exploring physics education from identity and gender perspectives, I wanted to approach biology education with these perspectives, exploring biology cultures, sociocultural practices, and possible identities in a Swedish higher education context and beyond. This study uses feminist explorations of identities in worlds of higher education biology moving beyond exploring possible identities mainly in male-dominated such as physics and engineering. That is, this study aims to move beyond ideas of biology as a gender-neutral discipline reflected in the numerical female dominance in undergraduate recruitment across European countries. It is a study that explores norms, discourses, and imaginaries that invite some to participate in biology practices, some to identify as biologists, and some, but not all, to imagine their future paths in biology. Therefore, I aim to contribute to changing the discipline's educational cultures, making higher education biology a more equitable and just space for learning.

This thesis would not have been possible without the help of so very many people. First, it would not have started without Petra Korall, Anders Johansson, and Anita Hussénius and above all it would not have been finished without Annica Gullberg, Ingrid Ahnesjö, and Karin S. Lindelöf. Thank you for your trust, patience, and unconditional support in making this a semicolon, not a full stop!

Uppsala, April 2022 Katerina Pia Günter

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Indeed, it does take a village.
A rather big one!

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1 Introduction

Whose Science? Whose Knowledge? When thinking about women's lives, Sandra Harding (1991) called for new sciences, sciences that involve not only one kind of person, but sciences that involve diverse viewpoints, perspectives, knowledge productions, and people. These sciences would be decentred from white, heterosexual, masculine, Western thought. Sciences that are rethought.

Biology as a field of knowledge production has a unique position in the landscape of Western sciences. Derived from the Greek words *bios* meaning life and *logos* meaning study, biology studies life at different levels of organisation from small molecular units such as genes and proteins to cellular levels, to anatomies, morphologies, and physiologies of organisms, to diversities of life across populations and spatial distributions, to changes of life across time. At most Western universities, biology is categorised as and taught within natural science faculties, disciplinary contexts, a natural science discipline that studies the living natural world. However, it has also been argued that biology should be conceptualised as a social science, since biology as a discipline also produces anthropocentric views on the living while being influenced by these very anthropocentric productions, especially in the context of evolutionary biology (Harding 1986; Keller 1984, 2016). Although biology is a field of knowledge production that has contributed to understanding life, it has also contributed to essentialist and binary constructions of sex and gender, the masculine and the feminine, tearing and being torn by the divide of the subjective and the objective, a divide of nature and culture, body and mind (e.g. Ah-King 2010; Fausto-Sterling 1985; Harding 1986, 2008, 2016; Keller 1984, 1985).

Whose science? Whose knowledge? In the context of higher education science and higher education biology, these questions turn into other questions: What is science? What is knowledge? Who is invited to think science? Who is invited to rethink knowledge? Sandra Harding (2006) highlights that even though barriers of gendered, racialised, and classist discriminations and exclusions from participation in science and in scientific knowledge production are believed to have been formally eradicated in, for example, Europe, institutionally underserved minority groups such as women, gender non-binary people, people of colour, and working-class people are still underrepresented in science practices and scientific knowledge productions. Diversity work in academia, said not done, keeping structures and people in place rather than transforming institutions (Ahmed 2016). Taking a closer look at the numerical

gender distributions of biologists in higher education institutions more than 35 years after Harding (1986) called for change, we can see that in many European countries such as Sweden, Germany, and the UK the majority of undergraduates in higher education biology identify as female (SCB 2021a; Statistisches Bundesamt 2021; Universities UK 2019). Although the numerical domination of women on the undergraduate level has been used to claim that biology as a natural science discipline has solved the problem of gender disparities (problematized by e.g. Eddy et al. 2014; Eddy and Brownell 2016), gender neutrality discourses and assumptions of actual gender neutrality keep obscure gender troubled positions (e.g. Silfver et al. 2021), they hide and deny that women and minority groups are being disadvantaged (Acker 1990; Eisenhart and Finkel 1998). Rather than displaying actual gender neutrality, an independence from gendered practices, gender neutrality itself neutralizes masculine coded dominant discourses and thereby unmarks them (Gonsalves, 2014 also referring to Salzinger, 2004). Numbers in higher education biology point towards gendered processes from a quantitative viewpoint and recent studies have started to indicate that, for example, female students' academic performances in undergraduate biology classrooms are underestimated (Grunspan et al. 2016). Also, self-perceptions towards biology differ along intersecting axes of gender, race, and ethnicity although not as much as in physics (Hazari et al. 2013), and female university biology teachers experience hierarchies along the axes of gender in a Swedish higher education biology context (Andersson 2018).

Although 67% of all Swedish first-year undergraduate students are registered as female (SCB 2021a), we see a decline in female students' participation in higher education biology reciprocally proportional to the academic career ladder (SCB 2021b). The higher we climb, the fewer we are. In contrast to other natural sciences and STEM (Science, Technology, Engineering and Mathematics) disciplines such as chemistry and especially physics, biology does not depart from a numerical male bias at the undergraduate level but departs from being a numerically female-biased science discipline, gradually becoming more and more numerically male-dominated at higher academic levels. This makes biology particularly interesting to study from gender and science education perspectives. Evelyn Fox Keller (1985) describes the strong interrelatedness of the construction of science practice and the intellectual endeavour of science with norms of masculinity, and Harding (1986) highlights asymmetries in how biological theory is constructed, how research is conducted, and people within valued. These 'exceptionalist and triumphalist philosophies in science' (Harding 2008: 23) and 'patterns of institutional practice and of scientific culture' (Harding 2008: 104) are grounded in white, heterosexual, middle class, Western, male perspectives and lead to disrupted science identities along intersecting axes of power, making possibilities and impossibilities of science identities political (e.g. Avraamidou 2020a; Avraamidou and Schwartz 2021; Brickhouse et al. 2000; Carlone and Johnson 2007).

As higher education science and higher education biology are intertwined with larger historical, cultural, and societal discourses, Sweden becomes a particularly interesting case in terms of gendered (in)equalities. In Sweden, societal discourses of having reached gender equality both from inside and from outside are stronger and more present than in other European countries (Andersson 2012; Gullberg et al. 2014; Lane and Jordansson 2020). Martinsson, Griffin, and Nygren (2016) challenge and dismantle the myth of gender equality in Sweden; according to them, and in comparison with other European countries, Sweden has 'the most institutionalized model of gender equality' (2), but this dominant normative discourse of a gender-equal Sweden both produces and is produced by 'naturalized, nationalist, hetero-cisnormative and racialized positions in a postcolonial and neoliberal time and space' (1). In the same volume, Angelika Sjöstedt Landén and Gunilla Olofsdotter (2016) note that 'the fantasy of gender mainstreaming is intended to close off critiques of institutionalized practices and to maintain the reputation of Sweden as the champion of mainstreaming gender equality' (180), reminding one of biology as a natural science discipline to be almost unchallenged in its fantasy of gender neutrality. As the authors suggest, I want to stick with the messiness of exploring institutional spaces that are discursively constructed as gender-equal.

Whose science? Whose knowledge? These questions turn into other questions: Whose biology? Whose biology knowledge? Who is biology? Who is invited to do biology? Ultimately, these questions turn into questions of what ways of being, what ways of knowing, and what ways of doing are (re)produced in higher education biology. This thesis aims to explore intelligible identities available to students and teachers by exploring cultural norms and (hegemonic) discourses influencing participants' learning and identity work.

1.1 Research aims and questions

This thesis explores higher education biology from social constructivist, cultural, and feminist theoretical perspectives. Specifically, this thesis asks what ways of being, what ways of knowing, and what ways of doing are practiced and recognised by both students and teachers in worlds and landscapes of higher education biology. That is, this thesis aims to challenge imaginaries of biology as a gender-neutral natural science discipline to explore participants' identities that are imagined as intelligible, to map overlaps and tensions in and between students' and teachers' identity work, and to address (re)productions of higher education biology cultures. My thesis contributes to broadening the scope of gender studies as a discipline by transgressing several disciplinary boundaries while widening the field of science and biology as well as science and biology education research through its gender perspectives.

When pursuing this exploration, the following questions guide the development of my thesis:

1. What identities and what identity trajectories are imagined as intelligible by students and teachers, both for themselves and for others in worlds of higher education biology?
2. How do students' and teachers' imaginaries relate to each other?
3. How do discourses in biology form and get formed by overarching gendered discourses of and in science?

In the first article included in this thesis, Paper I, I explored first year students' imagined identity trajectories at a Swedish university. Analysing their study motivation texts and visualising how they figured the world of higher education biology, I began to operationalise the above-mentioned questions with a sensitivity for who is considered a "biologist" following a typical or alternative trajectory in higher education biology and what ways of being, what identities, were recognised by students for themselves and others. I found that the straight paths from being a scientific child to wanting to become a researcher contrasted with imaginaries of winding paths where biology knowledge is collected for interdisciplinary use inside and outside academia. In terms of the development of the thesis as a whole, the analysis in Paper I prompted further explorations of ways of being, knowing, and feeling in higher education biology in larger discourses of higher education science. In Paper II, I focused on university biology teachers at a Swedish university. Through analysis of teachers' teaching statements (teaching philosophy texts written when applying for university teacher positions), I extracted how teachers imagined intelligible biology identities for both the students they encounter and for themselves and was again particularly interested in the identities they recognised for themselves and others. Like the students' imaginaries in Paper I, university teachers positioned research identities as central in practices of higher education biology; however, they also challenged this dominant imaginary. Paper II discusses how relating selves in line with or divergent from researcher identities inhibit or make it possible for teachers to position students as knowers and themselves as learners and thereby problematises the centrality of research in higher education biology practice. In Paper III, the empirical material from Paper I and Paper II was revisited to explore how students and teachers made meaning of and directed enthusiasm, passion, and interest. I found that students and teachers on the one hand tightly intertwined emotions with ideas about and practices of science and research. On the other hand, these emotions were made meaning of in broader terms and directed towards activities beyond research and academic contexts. I discuss how overlaps of and tensions between made meanings bear the potential to enhance and inhibit students' identity work and thereby challenge ideas about enthusiasm, passion, and interest

as collectively understood and inherently positive in science and science education. In Paper IV, the last article included in this thesis, I move from a solely Swedish context to a transnational and European context, interviewing biology students from a Swedish, a German, and a British university. Empirically grounded in 27 interviews from the three European universities, Paper IV more closely explores the identity work students imagining worlds of higher education biology. Along six interviews, I describe three imaginaries of dominant science practice in relation to which the students negotiated their identities in relation to across the material. Through more detailed descriptions of how three successful female students related to these imaginaries, I was able to show that despite having learned to navigate these imaginaries, the students struggle to fully embrace them. They understand themselves to be successful *despite* needing to relate to hegemonic imaginaries of what it means to do not only biology but also science, which challenges the very practices as well as assumptions of successful students to agree with implicit disciplinary practices.

1.2 Structure of the thesis

This thesis, which is divided into eight chapters, aims at synthesising the research reported in Papers I–IV. After having introduced the study, its background, research questions, and aim in Chapter 1 (Introduction), I situate myself and my research in a larger context in Chapter 2 (Situating myself and situating my research). In Chapter 3 (Theoretical framings), I give an overview over the theoretical framings used in the four papers included in this thesis. In Chapter 4 (Methodology), I connect the theory to the methodology, which includes both descriptions of data collection and analysis as well as reflections on reflexivity when conducting discourse analytical work from the inside and outside. In addition, this chapter includes reflections on how to do ethical research. In Chapter 5 (Findings), I summarise the findings from the four research papers included in this thesis and provide the foundation for the subsequent Chapter 6 (Discussions), where I discuss the findings in a larger and synthesised context. In Chapter 7 (Contributions and implications), I present the thesis' contributions in the context of its findings and in Chapter 8 (Concluding remarks), I present some concluding reflections on the work.

Each of the following chapters will begin with an autoethnographical vignette that reflects on experiences from different phases of my own academic career. These vignettes aim to transgress the personal and the professional to further situate myself in my work.

2 Situating myself and situating my research

Chat recognitions

During the online ESERA (European Science Education Research Association) doctoral summer school 2020, Michael Reiss, a well-known science education researcher, gave a keynote[1] titled *What kind of researcher do you want to be?* He suggests four "sorts" of research that one can undertake:

(i) quantitative, qualitative, and mixed methods;
(ii) understanding an issue;
(iii) improving something in the world; and
(iv) understanding yourself.

Moving from biology to gender studies, from quantitative to qualitative work, (i) made sense to me, so did understanding an issue (ii) as, in this project, I wanted to understand why some people call themselves biologists and others do not. As a PhD student, I could not see the possibility of improving the world (iii), but it seemed likely that my PhD studies would reveal something about myself (iv). After contemplating these categories, I could not let go of the third question; indeed, I wanted to contribute to change, but it also felt like I was constantly hitting walls. So, I asked:

If one is to contribute to change, how shall we negotiate our already vulnerable positions as PhD students as being in between disciplines adds the difficulty of finding one's position in the field?

He agreed with me that as a PhD student one is 'vulnerable in a number of ways'. He suggested that I should aim at finishing my PhD and publishing articles from this work. He highlighted that there is a lack of research in science education that connects who the researcher is with the work that they do, suggesting to publish a reflective piece on one's work in either *Cultural Studies of Science Education* or *Science and Education*, especially the latter as it is one of the leading journals in science education research.

Making myself vulnerable by asking how to negotiate vulnerability was intensified further by the suggestion that I publish in highly ranked journals, a goal so high and so far away from my reality. Another researcher, however, sent me a private message that said that they loved my question.

That private message made me feel connected.

[1] Available on https://esera2020ss.web.ox.ac.uk/esera-vdn-plenary-details (2021-11-14)

Feminist work and feminist science critique have scrutinised scientific worldviews, ways of seeing, and ideologies of objectivity in the production of scientific knowledge, contrasting ideas of recognised epistemologies within natural sciences to, for example, social sciences (see e.g. Harding 1986; Haraway 1988; Longino 1987). Knowledge production within the social sciences is recognised as a process that includes culture in historical and social contexts of meaning, which are often driven by subjectivities, feelings, and emotions. This view stands in strong contrast to recognised epistemologies in the natural sciences. The natural sciences, and especially physics, are constructed as disconnected from all subjectivities, free from social values, merely focused on objectivity and objective inquiries. This rejection of subjectivities is a central point of critique by feminist science philosophers, dismantling myths of, for instance, physics as a natural science as 'a culture of no culture' (Traweek 1988). Biology as a discipline finds itself in tension between the social and natural sciences: biology and nature versus culture and nurture in terms of knowledge production and epistemological commitments in academic territoriality (Keller 2016). The persisting yet mythical claim that science concerns objectivity as if a 'gaze from nowhere' (Haraway 1988: 581) has been problematised and described as actually being views from *somewhere*: visions from white, male, and heterosexual positions of power (Haraway 1988), dichotomies of nature and culture challenged through constructs of natureculture (Barad 2007, Haraway 2003). Through exclusions of other perspectives, this somewhere reproduces sexist, classist, and racist scientific practices of knowledge production as well as knowledges (Harding 1986).

My thesis is a claim from somewhere, participating in subjective knowledge productions that are informed by who I am as person, the environments that I find myself in, the literature that I read, and the people and other critters and companions that I interact with. My knowledge is situated (Haraway 1988) and by disclosing who I am, an act of making myself vulnerable, I want to resist simplifications in my accounts of the world. I aim at visualising the entanglement between who I am, what I do, and consequently what I can see or do not see, practicing both reflexivity (Davies 2012, Hemmings 2012, Sultana 2007) and transparency with regard to how this thesis and its papers have been produced. Throughout my productions of knowledge, I ask myself two questions: What kinds of knowledges am I able to produce? How does this contribute to and develop existing knowledges?

This thesis and the approaches I have chosen are an introduction of myself as a person to you reading these lines and the field(s) and discipline(s) you represent. They came into existence along my own learning trajectory and position my work in the scientific landscapes and communities of academic practices that I find myself in, between, and among.

2.1 Myself

I am and I pass as white. I was socialised and oriented into using the pronoun she growing-up in a conservative, Christian part of southwestern Germany. Uncomfortable with intelligible femininities around me and what they allowed or did not allow me to be, do, wear, and know, yet comfortable with the very pronoun she and identifying as a woman, I experienced a strong sense of unbelonging in gender-binary and heteronormative conservative environments, which disoriented and reoriented my way to identifying as a queer woman. I transgressed my working class and lower middle class background being a first-generation university student and the first one in my core family to pursue a PhD degree not only through my university studies but also through alternative makings of kin, extending my family with humans and non-humans that feel like and quickly became my family. These close connections to other beings, having spent my childhood summers in different European countries such as Italy and Greece and some of my teenage summers and autumns in the US as well as growing up with my first dog Bonnie and now Rumo as companions, have shaped me as a human, as a private person as much as becoming an academic; whatever that means.

Not fitting stereotyped ideas about feminine, diligent, teenage, female students, I graduated from high school in the top three in my class, to many people's surprise. I then pursued and now hold a bachelor's degree in biosciences from a, in German terms, elite[2] research[3] university in Germany ranked as one of the top universities in the world[4]. After my bachelor's, I started a master's degree at another highly ranked elite German research university. To gain more international experience, I decided to participate in an ERASMUS exchange with a university in Sweden and after one semester changed programs to and continued my master's at a Swedish university, graduating in biology with a major in systematic biology. The Swedish university, again, was an old and prestigious university, high on the international ranking. I also had the chance to experience other higher education environments in Switzerland and the US through field courses and short professional and private visits. Study-

[2] While being critical towards the concept and idea of 'elite' and the power that it holds, elite in a German context of the governmentally funded 'elite initiative', *Exzellenzinitiative des Bundes und der Länder zur Förderung von Wissenschaft und Forschung an deutschen Hochschulen*, is a main driver of national university discourse. In later parts of this thesis, I problematise the term elite as not being limited to the German context. This is an example of how the discourse produces and more importantly reproduces discourse.

[3] I am also aware of the use of 'research' in the descriptions of the universities described and draw on the universities' own descriptions. Without exception, all universities included in this thesis, at the point of writing this thesis, no matter if it is the one's that I myself have attended or the ones the students in this work attend, name research as their primary and teaching as their secondary aim in their introductory and philosophy statements.

[4] According to https://www.timeshighereducation.com/world-university-rankings/ (2021-11-09).

ing at and experiencing different higher education environments, being exposed to and negotiating elite discourses of excellence, and relating to and being part of the elite discourses of excellence has shaped my experiences as a student and as a teacher at these institutions. While wondering throughout my studies about what elite actually means and rarely feeling as if I belonged, I had the chance to work as a teaching assistant by my second year as a university student. I found myself between institutional identities of being a student and being a teacher. Transitioning into being both a teaching assistant in laboratory courses and a tutor lecturing in lecture halls, becoming linked to and a link between participants and institutional practices, I started seeing links between these participants and practices. Experiencing different educational environments from different institutionalized positions made me apply for and develop this thesis project.

Although formally educated in biology, I transitioned towards gender studies working on a project with higher education biology as the object of study. This transition made me an insider and an outsider of both disciplines as well as of science education as a field. Furthermore, it has influenced my own identity work being in interstitial spaces, carrying with me different kinds of cultural practices, knowledges, and theories (Hussénius et al. 2016). Throughout this thesis, I will position myself in autoethnographical vignettes, snapshots from moments and reflections that moved and directed me in different ways, moments that stuck with me, that I got stuck with. I consider these moments central to shaping me, my thesis project, and what knowledge I can produce and how my knowledge is situated.

2.2 My research

This project is situated in and informed by critical and feminist pedagogy and seeks to advance democratic ideals as well as deconstruct what is deemed to be knowledge, how things come to be known and by whom, what knowledges are recognised, as well as who is considered knowledgeable (Marchbank and Letherby 2014). According to Carolyn M. Shrewsbury, feminist pedagogy is

> engaged teaching/learning—engaged with self in a continuing reflective process; engaged actively with the material being studied; engaged with others in a struggle to get beyond our sexism and racism and classism and homophobia and other destructive hatreds and to work together to enhance our knowledge; engaged with the community, with traditional organizations, and with movements for social change. (1987: 166)

Critical and feminist pedagogies focus on how power reinforces social structures as well as how power operates and is employed by dominant groups. For Foucault, power is not possessed but exercised and constantly produced

in interactions (Andermahr et al. 2000; Foucault 1977, 1980). Power has multiple ways and arenas in which it operates such as the arena of sex and gender and the arena of science and science education. Power is a mediator between social structures and identity in processes of learning (Wenger 1998).

Before I explicitly elaborate on how gender theory is embedded in this thesis, I want to give a historical account on where this thesis is placed in relation to feminist science education, feminist science critique, and the concept of science identity, all arising from feminist perspectives of science education. As much as all the stories told in this thesis, this is one way this story can be told. As Donna Haraway (2016) teaches us, 'it matters what stories we tell to tell other stories with' (12), and Clare Hemmings (2011) even more so makes us aware of the dilemmas of repeating narratives that have made and unmade histories. This is a story of Western feminist science education and while it allows me to position this work in a certain historical and cultural context, it does not mean that this story is ultimate, complete, and unproblematic.

2.2.1 Feminist science education and feminist critique of science

In *Feminist Science Education* from 1998, Angela Calabrese Barton maps the historical landscape of the development of feminist science education in relation to waves of the feminist movement. The first wave of feminism called for access to education not only for men but also for women. As Mary Wollstonecraft (2014 [1792]) in *A Vindication of the Rights of Women* famously wrote, 'Men and women must be educated, in a great degree, by the opinions and manners of the society they live in' (31). This movement led to a professionalisation of teaching and created opportunities for girls to participate in general education (Sanders 2004) and science education (Barton 1998), leading to educational spaces being widened (Scantlebury and Baker, 2007). Although the widening of educational spaces was the foundation of further openings of academic spaces for women (David 2016; Midkiff 2015), science practices themselves have not been critiqued (Barton 1998).

The second wave of feminism broadened debates of gender inequalities and critiqued male-dominated institutions and cultural practices throughout society (Evans 1995), which influenced feminist philosophers of science such as Keller (1985) and Harding (1986, 1991). By reflecting on gender and science as well as asking questions about science in feminism, they dismantled androcentric and positivistic traditions of science and scientific practice and question science's ideology of objective, gender-neutral, and value-free knowledge production. According to Haraway, a strong focus on objectivity in science leads to partial perspectives:

> The moral is simple: only partial perspective promises objective vision. All Western cultural narratives about objectivity are allegories of the ideologies

> governing the relations of what we call mind and body, distance and responsibility. (1988: 583)

An ideological and falsely assumed distance leads to a lack of responsibility for what it is that can be seen. To transgress partial perspectives, Haraway (1988) suggests acknowledging that knowledge is situated and embodied, a matter of community rather than individuality. Hence, everybody produces knowledge from particular standpoints influenced by social forces (Harding 1993; Keller 1984, 1988).

Producing knowledge through our human cognitive apparatus, as Longino (1994) calls it, requires making the very positions from which one speaks visible, connecting knowledges to the knower rather than separating knowing from the being who knows. Second wave feminist science education builds on these critical perspectives of natures of science as well as scientific knowledge production and aims at incorporating marginalised people and their culturally and socially constructed ways of knowing (Barton 1998). Haraway, Harding, and Keller understand science and the scientific practice to be socially constructed and 'used in the service of sexist, racist, homophobic, and classist social projects' (Harding 1986: 21). The stereotype of Western science as masculine has simultaneously been identified as a major barrier to participation in the sciences (Kelly 1985) and has later been connected to sociocultural aspects such as gender role expectations towards women, which leads to tensions when negotiating a career in science (Kahle and Meece 1994). Grounded in further research on how marginalised groups were stereotyped and excluded from participation in science communities along different social dimensions of power (Barton 1997; Brickhouse 1994; Brickhouse et al. 2000; Eisenhart and Finkel 1998), gender-inclusive and liberatory science education emerged in the overlap of the second and third wave of feminism (e.g. Barton 1997).

The third wave of feminism is described as an action and a movement forward rather than solely as a reaction to inequalities. This third wave wants to 'understand power structures with the intention to challenge them' (Walker 2001: 80) along a multitude of power dimensions. Rooted in, for example, bell hooks' (1981) and Kimberlé Crenshaw's (1991) analyses and theorisations of intersecting and overlapping layers of oppression, the third wave of feminism transgresses structuralist binary notions and sheds light on the complexity of identity politics embedded in poststructuralist movements. Intersectionality is closely linked with postcolonial and anti-racist feminist movements, which point out, problematise, and deconstruct white, Western, middle-class feminist perspectives (e.g. Mohanty 1988).

Key philosophical concepts in the poststructuralist movement are discourse, power, and knowledge (St. Pierre 2000) and deconstructions of how discourses are intertwined with, produce, and reproduce identities. Barton (1998) points out that because feminism as a political movement not only aims

at deconstructing oppressive and hegemonic practices but also at reconstructing them, teachers and students in scientific knowledge productions become 'agents and actors who actively and collectively shape and reshape their own understanding of the world from specific viewpoints' (15). They have the agency to produce and reproduce scientific knowledge productions.

In their extensive review on gender, science education, and engaging girls in science, Brotman and Moore (2008) identify four themes: equity and access; curriculum and pedagogy; reconstructing the nature and culture of science; and identity. They highlight a first paradigm shift prompted by critical feminist research—from girls needing to be changed to educational systems needing to be changed (cf. Scantlebury and Baker 2007 and Steegh 2020)—as well as a second shift towards more critical and feminist theoretical frameworks that are strongly related to the themes of reconstructing the nature and culture of science and identity (Brotman and Moore 2008). The latter themes are strongly intertwined with shifts in feminist science education as a reaction to feminist critique of science, understanding science practice as always gendered (i.e. never gender-neutral) (Brickhouse 2001) on structural as well as symbolic levels, exceeding the individual (e.g. Hussénius et al. 2013, 2014). Feminist researchers such as Carlone (2004) aim to critically examine and display how science is a culture, is cultural, as well as to bring these critical perspectives towards science into the classrooms. Embedded in social constructivism, participation in science classrooms is understood as tightly linked to discourse, agency, and identity (Barad 1996, 2007; Burr 2003; Gee 2014 [2011]; Lave and Wenger 1991; Wenger 1998), and identity, identity work, and the concept of science identity starts to emerge in science education literature (e.g. Brickhouse 2001; Brickhouse et al. 2000b; Brickhouse and Potter 2001; Carlone 2004).

2.2.2 Science identity and biology identity

Science identity is a central concept in this thesis as it is historically and ideologically rooted it feminist critique of science and feminist science education, poststructuralist theorisations of discourse and power, and the belief in a need for change. The concept of science identity, although mentioned in earlier work, has gained momentum after Carlone and Johnson (2007) described science identity as being built on the pillars of *performance*, *competence*, and *recognition*, explicitly including intersecting axes of power; gender, race, and ethnicity. The field of science identity research is not limited to STEM and natural science education in primary and secondary education (e.g. Archer et al. 2010; Carlone 2003; Carlone et al. 2014; Jackson and Seiler 2017; Wade-Jaimes et al. 2021), as it also extends to out-of-school contexts (e.g. Dawson 2014), higher education (e.g. Avraamidou 2020a; Espinosa 2009; Gonsalves et al. 2019; Hazari et al. 2013; Holmegaard et al. 2014; Johansson 2018; Malm et al. 2020; Ong et al. 2011), as well as science teacher education (e.g. Archer

et al. 2017; Avraamidou 2016, 2020b; Danielsson et al. 2016; Mensah 2012, 2016) to name a few.

Science identity research in higher education has grown significantly in the last decade especially in the context of numerically male-dominated science disciplines such as physics and engineering, which I consider rather problematic. It bears the risk of reproducing the exceptional position of physics within the natural sciences also within the field of science identity research and of overlooking nuances in understandings and connotations of *science*. Science identity is often combined with other theoretical concepts and more critical voices have suggested science identity as a concept with even more potential than so far acknowledged to understand how ideas about the nature of science influence the way participants negotiate belonging or unbelonging to science practices (Avraamidou and Schwartz 2021). In this thesis, I contribute to the expansion of productions of knowledge about science identities in higher education towards biology, a natural science discipline that is rather marginalised in the science identity field.

Although Carlone and Johnson (2007) included biology in their initial study, they never explicitly address disciplinary biology identities. However, a few studies can be found that apply a science identity lens to a variety of higher education biology contexts. Zahra Hazari and colleagues (2013) compare biology, chemistry, and physics and students' identity work and self-perception along the axes of underrepresented minority group membership and gender. They found higher levels of identification to biology for white women than for black non-Hispanic and Hispanic women and men as well as white men and provided further evidence that biology is not a gender-neutral discipline. Sarah Eddy, Sara Brownell, and Mary Wenderoth (2014) explicitly address the numerical female bias in large introductory biology classes for biology majors and explore academic achievement and participation in whole-class discussions as measures of gender disparity. Similarly to Moss-Racusin et al. (2012), the authors found subtle gender(ed) gaps in female and male students' performances that suggest a need for more nuanced research with greater focus on intersections of science identity and gender. Gloriana Trujillo and Kimberly Tanner (2014) have developed a tool that assesses undergraduate biology students' science identity and efficacy as well as sense of belonging in higher education biology, theoretically connecting ability beliefs, sense of belonging to the community, and formations of science identities. Furthermore, Jeff Schinske et al. (2016) implement counter-stereotypical examples of scientists in homework assignments in an introductory biology class at a diverse community college as a tool for students to actively work with their science identity in a quasi-experimental study. They found that these students began to use more non-stereotypical descriptions of scientists. Although touching on science identity and suggesting the concept for further studies, neither Trujillo and Tanner (2014) nor Schinske et al. (2016) use science identity as an analytical lens when exploring how undergraduate biology students

and other participants in higher education negotiate ways of being and doing in biology and science practices. Paul Le, Leanne Doughty, Amreen Nasim Thompson, and Laurel Hartley (2019) explored how students negotiate their conceptual identity and procedural identity in five introductory biology courses. Framed as lived experiences in figured worlds, the authors found that students negotiated their identities in cultures of science in contradictory ways and that students 'internalize[d] both inclusive and elitist discourses in their production of their science identities' (Le et al. 2019: 13). The authors suggest encounters with environments play a major role in the students' identity work and therefore sensitivity for the norms and values in these surrounding landscapes needs further investigation. When shadowing female university biology teachers at a Swedish university, Kristina Andersson found meritocratic discourses of gender neutrality in tension with a biology environment where 'the man is the norm' (2018: 72).

Situated in a Swedish and European context and rooted in feminist science education, I explore landscapes and worlds of higher education biology and norms and values that shape and are shaped by these worlds. Therefore, my thesis contributes with important insights into higher education biology and higher education science practices from both students' and teachers' perspectives and makes visible the complexities of negotiating communities, identities, imaginaries, emotions, and belongings in worlds of higher education biology. This thesis thereby also acts as a counterweight to the extensive use of science identity in male-dominated natural science disciplines.

3 Theoretical framings exploring identities in higher education biology

We in biology

> COVID-19 affected all of us in different ways and I was yet again in a virtual meeting with people from different faculties and different disciplinary backgrounds. What brought us together in this Zoom room—a space where one raises virtual hands when wanting to talk, a space where people with bad internet connections drop out of the meeting, a space where one cannot just discuss something with the person next to them—were discussions on connecting students at a distance even though we ourselves were disconnected from each other. Discussions arose about how the different faculties handled the pandemic as well as digital teaching. One person said, 'we in biology, I mean we in life sciences'. I stopped listening and started thinking. What does it mean, not biology but life sciences? It can mean that they wanted to be more inclusive and include all somewhat biology-related disciplines and physical spaces and people in those spaces as if we could change entire biology programmes at universities into bioscience programmes (i.e. changing to include). But for me it meant something else.
>
> Working with this project has made me reflect on many kinds of frames. How one frames and reframes projects. How we frame ourselves. How others frame others. How we frame things. How things are framed. How things frame us. What does it mean to use life *sciences* instead of biology? Life *science* instead of the study of life, biology? Rather than seeing the use of *science* in life science as including, it rather feels like a linguistic change that excludes, emphasizing what brings us together to be the *science*, not biology.

Theory can be perspectives, explanatory models, and tools that inhabit and are built on thesis or hypothesis (Gunnarsson Payne and Öhlander 2017). While developed in dialogue with practical and empirical knowledge, theory directs empirical explorations by providing a framework, a guiding epistemological as well as ontological structure, and methodological systems embedded in larger paradigmatic fields of knowledge and knowledge production (Andermahr et al. 2000). Theory also provides structure for inquiry but is structured by its assumptions, theses, hypotheses, and interconnecting concepts, which

make it possible to explore empirical phenomena, leading to a deeper understanding of the very phenomenon explored (Gunnarsson Payne and Öhlander 2017). In other words, theory is made through and remade in empirical engagements with the social world.

In this chapter, I first problematise the term *gender* and describe what I mean when I use it. I then describe the larger paradigmatic and ideological fields of knowledge and give a short overview of how I see the larger paradigmatic underpinnings used in this theses to be connected. Next, I map the concepts within these fields and detail the theoretical concepts employed and developed in this thesis in relation to the empirical contextual environment, which form the theoretical frames at work in this thesis.

3.1 Matters of gender, gender that matters

Gender (in Swedish *genus* and German *Soziales Geschlecht*) is often considered to be the socially constructed expression of biologically determined sex (in Swedish *kön* and in German *Biologisches Geschlecht*). This binary division of gender and sex itself is subdivided dichotomously into female and male sex as well as feminine and masculine gender. That is, gender is the 'expression of difference' between male and female, men and women (Connell and Pearse 2015: 11). These dichotomies have been problematised, criticised and deconstructed by feminist critique in general and feminist critique of biology. In *Myths of Gender*, Anne Fausto-Sterling, professor emerita of biology and gender studies with a background in developmental genetics, discussing deterministic biological theories, suggests that not only gender but also biological sex is socio-culturally constructed (1985). Lynda Birke, a feminist biologist with a PhD in animal behaviour, criticises biological determinism and unfolds the potential of biological determinism to justify existing social arrangements (1986). In addition, biological sex as a "fact" in Western sciences has been critically examined by Veronica Sanz (2017), a philosopher of technology working with science and technology practices oriented toward social justice. Sanz problematises the concepts of anatomical sex, gonadal sex, hormonal sex, chromosomal sex, genetic sex, brain/neural sex, and genomic sex: 'unified theory of sex presents a linear model in which all variables—from genes to external anatomy—align along one of two possible paths due to a process of causal dependency' (2017: 15). Sanz concludes that even though evidence for sex as a non-binary construct is overwhelming, the historical power of the binary concept of sex is overpowering and reproduced in a 'circular network' (2017: 23). In a Swedish context and building on Anne Fausto-Sterling's work, Malin Ah-King (e.g. 2010, 2012; also see Ah-King and Nylin 2010) discusses, problematises, and dismantles gendered norms in a variety of disciplines within biology with a particular focus on evolutionary biology.

Ah-King together with Ingrid Ahnesjö (2013) scrutinise sex stereotypic expectations and terminology and the sex-role concept in biology, highlighting variations in reproductive ecologies. The authors show how socially and culturally constructed anthropocentric and heteronormative beliefs of behaviour influence knowledge productions in evolutionary biology. The reproduction of binary and heteronormative approaches to sex/gender through biological determinism and a heteronormative rhetoric has also been problematised by e.g. Annica Gullberg, who concludes that 'a complex net of interactions of social, cultural, historical and biological causes' influence human behaviours—i.e. people's ways of being in the world (2018: 78–79).

Judith Butler (2007 [1990]) argues from a poststructuralist viewpoint that both biological sex as well as sociocultural gender are discursively constructed and reproduced in sociocultural power regimes. Gender, according to Butler, is constructed along a heterosexual matrix, which through the power of discourse normalises and naturalises a dichotomous model of gender as female and male, which discursively regulates and in turn is regulated by sexuality. Butler argues for an absence of essentialist connections between body, sex, gender identity, and gender performance and highlights relationships and hierarchies among and between gender identity and biological sex to be a regulated processes of ongoing repetition and rule-generated with 'rules that condition and restrict culturally intelligible practices of identity' (Butler 2007 [1990]: 198). Following Austin's (1997 [1962]) idea of performative language, Butler emphasises the concept of performativity in the context of gender—i.e. viewing gender not as a state but as an ongoing process, a doing, rather than a being, with the repetition of acts at the centre of the production of gender and gendered norms:

> [A]cts, gestures, enactments, generally construed, are performative in the sense that the essence or identity that they otherwise purport to express are fabrications manufactured and sustained through corporeal signs and other discursive means. (2007 [1990]: 185)

In this thesis and when transitioning from biology into gender studies, I grappled with how to approach gender in my research. On the one hand, I root this work in poststructuralist theorisations on gender as a performative socio-culturally constructed concept that is fluid, always undergoing reshaping (Butler 2007 [1990], 2011 [1993]), and extend the concept to identities outside of gender identities. On the other hand, I thereby also draw on the very binary categories of female and male, categorise students and teachers as female, male, and gender non-binary to explore people's experiences along the dimension of gender categories. This struggle has also been described by Andersson: to see gendered processes, one needs to make use of the very categories that one contests (2011). Although Judith Butler (2007 [1990]) problematises the category gender and conceptualises gender as a performance, a performative

act of repetition rather than an essence, they also highlight '[t]he task is not whether to repeat, but how to repeat or, indeed, to repeat and, through a radical proliferation of gender, to displace the very gender norms that enable the repetition itself' (203). In this thesis, I consciously draw on gender binaries and through that repetitive act make visible the norms that socioculturally constructed bodies experience and need to negotiate their identities in relation to in practices of higher education biology.

3.2. Studying identity in higher education biology: combining feminist, social constructivist, and cultural perspectives

This thesis builds its theoretical framework on cultural and social constructivist perspectives as well as feminist theoretical perspectives. Cultural theory allows me to embed this thesis in the idea that culture is everywhere and is done, communicated, maintained, and re-created in communication (Gunnarsson Payne and Öhlander 2017). Culture as done in communication overlaps with poststructuralist theories of discourse—i.e. language in use that shapes and is shaped through social interactions. Language and the ways we talk about and understand the social world surrounding us, structure and are structured by the language we use—which also means that signs communicated through language yield meaning, structure discourses, and transform and maintain discursive practices (Jørgensen and Phillips 2002). Discourses themselves are embedded in and create larger relations of power, power that is executed rather than owned and has the potential to make possible and to make impossible (Foucault 1976). Discourses struggle for hegemony (Laclau and Mouffe 1985), ideological and dominant sets of ideas in cultural landscapes (Gramsci 1971), dialectically producing and reproducing structures of power in practice. Feminist theorists, concerned with these structures of power and how power relations are negotiated (Mills 2004), show that gender is a force or rather "does" force. Gender becomes a verb that structures and stratifies cultures. It does so in relation to other power dimensions such as race, ethnicity, and class. As mentioned before, social categories intersect (Crenshaw 1989), as powerfully manifested by Sojourner Truth in her 1851 speech *Ain't I a Woman?*. In line with feminist and gender studies' transdisciplinary and post-disciplinary openness, this thesis participates in (re)negotiations of science, scientific epistemologies, disciplinary epistemologies, and practises (Haraway 2004), understanding sciences to be 'embedded in power struggles over disciplinary territories and borders' (Lykke 2010: 20). Hence, science disciplines become territories in landscapes and worlds whose dividing lines

are drawn through discursive practices—acts of repetitions that 'become domesticated and recirculated as instruments of cultural hegemony' (Butler 2007 [1990]: 189).

Using critical discourse perspectives, feminist critique of science constitutes the second theoretical and ideological fundament of this thesis and theoretically underpins sciences, including natural sciences, as historically-, culturally-, and socially-constructed practices and ideologies that are intertwined with capitalist, colonialist, racist, sexist, and masculinist hegemonies (Eisenhart and Finkel 1998; Haraway 1988; Harding 1986, 2008, 2011, 2016; Keller 1985, 1988; Schiebinger 1993, 2000).

Higher biology education and higher science education are spaces of discursive repetition, spaces that reproduce larger societal and cultural norms as well as situate scientific and disciplinary norms of knowing, being, doing, and feeling. From a social constructivist perspective, learning is not only the acquisition of content knowledge but also a process of becoming in particular contexts and in constantly ongoing interactions with others. According to Vygotsky (1978), everyone participates in social interactions using socially meaningful and connoted tools and signs, which makes the knower not an individual but a collective and social being. Hence, learning becomes a social endeavour and consequently the environment where learning takes place influences the processes of learning. That is, learning is socially theorised as a practice situated in communities where people move from a peripheral to a more central position through practices of enculturation (Lave and Wenger 1991; Wenger 1998). According to Wenger (1998), a variety of intellectual traditions intersect in social theory of learning. It combines not only theories of social structure and collectivity but also theories of identity, subjectivity, situated experience, meaning, belonging, emotions, participation, and practice, which are arranged along vertical and horizontal axes of power. As Wenger emphasises:

> the concept of practice connotes doing, but not just doing in and of itself. It is doing in a historical and social context that gives structure and meaning to what we do. In this sense, practice is always social practice. Such a concept of practice includes both the explicit and the tacit. [. . .] Most of these may never be articulated, yet they are unmistakable signs of membership in communities of practice and are crucial to the success of their enterprises. (1998: 47)

The question of what we learn becomes intertwined with the questions of where we learn, with whom we learn, and who we learn to become. Learning becomes intertwined with history, culture, society, and ultimately identity, negotiated through language use in communications and interactions[5].

[5] It is important to note here that even though Lave and Wenger acknowledge that power shapes legitimate participations, the concept of communities of practice has also been critiqued for not attending to how communities themselves are embedded in larger structures of power and therefore are influenced and influence negotiations of meaning. It can also be argued that what is

The two theoretical roots of this thesis—feminist critique of science (a branch of feminist theory) and critical discourse theory (deriving from linguistic theory)—attend to struggles for power in larger systems of practice and to natures of inequalities. Moreover, feminist perspectives sharpen the lens for explorations of inequalities based on gender in particular. In the following, I map the two larger paradigms connecting all articles in this thesis—critical discourse theory and feminist critique of science—and specifically describe and connect these approaches to other theoretical concepts applied in the respective papers (Table 1).

3.2.1 Critical discourse theory

This thesis studies language in use; specifically, it studies discourses in the worlds of higher education biology. The point of departure is the idea that language is not only used by people to communicate information but also influences the users of the language as language is a 'machine that generates, and as a result constitutes, the social world' (Jørgensen and Phillips 2002: 9). The meaning and use of the term discourse has been rather undefined, strongly depends on the disciplinary context, and can include or exclude oral communications (*speech*), written communications (*text*), visual communications (*images*), and physical communication (*gestures*) (Erdogan 2016). It can even include materialities (Mills 2004).

Table 1. Overview over the theoretical landscape of this thesis.

Paper	Overarching paradigms and concepts	Applied theoretical concepts
I	**Feminist Science Critique** (Harding 1986, 1991; Haraway 1988; Keller 1985) **Critical Discourse Theory** (Gee 2014 [2011])	**Intelligibility** (Butler 2007 [1990])
II		
IV		**Figured Worlds** (Holland et al. 1998) **Science Identity** (Carlone and Johnson 2007) **Performativity** Butler (2011 [1993])
III		**Communities of Practice** (Lave and Wenger 1991)

In this thesis, I consider discourse to include all forms of communication; as soon as there is interaction, as soon as there is language, there is discourse,

considered peripheral and central participation is itself a socially, culturally, and historically constructed reproduction. Through developing an eclectic theoretical and analytical framework, I want to acknowledge these complexities of ways of being in worlds.

and it is through language as discourse that we access reality and create meaning (Jørgensen and Phillips 2002: 8). This understanding of language as discourse originates in the discursive turn, a paradigm shift from considering language a vehicle of information to considering language only as meaning. The linguistic turn was a major development in Western philosophy during the early 20th century, focusing theoretical and analytical lenses on relations between language, language use, language users, and the surrounding world.

Discourse analysis has its starting point in both structuralist and poststructuralist linguistic philosophy where reality is always accessed through language (Jørgensen and Phillips 2002). In this work, I draw on traditions of critical discourse analysis; in particular, I build on theorisations of discourse by Paul James Gee (e.g. 2000, 2014 [2011]). Gee is in the tradition of critical discourse analysis and describes language and discourse not only as being an act of conveying information but also as a way of saying (as in *informing*), doing (as in *action*), and being (as a person developing their *identity*) as well as including oral, written, and physical communication. Discourse is described as language-in-use, as languages that are used in specific contexts to gain 'its meaning from the 'game' or practice of which it is a part and which it is enacting' (Gee 2014 [2011]: 10). Hence, language and its meaning is situated in ever changing contexts, contexts that just like games, are structured by explicit but also implicit rules. Situated meaning is given to words, phrases, and sentences depending on what is considered relevant aspects of the context, a context that exists in the world constructed and (re)produced in and through language and interaction (Gee 2014 [2011]). Saying something, according to Gee, cannot be understood without considering both the doing and the being, the performance of certain acts while at the same time being a certain kind of person who connects language to identity. In an earlier work, Gee builds his identity concepts on four identities—a nature identity (N-identity), a discursive identity (D-identity), an institutional identity (I-Identity), and an affinity identity (A-identity); these identities only come into existence through the act of being recognized (Gee 2000). In this work, I focus on the (inter)relation of D-identities, which are described as discursive identities upheld through the power of recognizing people as certain kinds of people, as well as I-identities, which are upheld by institutionalised power creating authored positions of authorities. These identities in the institutional context of higher education are strongly intertwined:

> We have seen that institutions have to rely on discursive practices to construct and sustain I-Identities, but people can construct and sustain identities through discourse and dialogue (D-Identities) without the overt sanction and support of "official" institutions that come, in some sense, to "own" those identities. (Gee 2000: 103)

As discourses and possible identities are embedded in institutionalized systems of power, the very systems of power at work in institutions can be made visible through explorations of discourses.

The way Gee describes discourses leaves me with the impression that he conceptualises them similarly to how the evolution of species has been conceptualised. Discourses, according to Gee (2000), can be split into two or more, yet they can also merge into one. Discourses can change over time and new discourses can emerge as old ones die out. That is, discourses are fluid and ever changing. To speak in biological terms, discourses evolve. Discourses are further described as intertwined with one another; they hybridise and their boundaries are always contestable. Most importantly, they are 'out in the world and history as coordinators [. . .] that betoken certain identities and associated activities' (56–57). Discourses make some identities and activities, ways of being and ways of doing, possible. Academia, specifically the natural sciences, are not excluded from historically and culturally constructed discourses—i.e. ideas about the doing, being, feeling, and saying in the practice.

3.2.2 Feminist science education and critique of science

Whose science? Whose knowledge? These are questions asked by many feminist science critics, including Sandra Harding (1991). As described in more detail when situating my research in Chapter 2, feminist science education and feminist critique of science both in theory and in practice inform my explorations of higher education biology landscapes. Feminist critique and feminist philosophy of science considers the acquiring of knowledge through Western scientific means and the very practice of Western science to be historically, culturally, and socially situated and thus that all knowledge is contextually situated (Haraway 1988). Situated knowledge means that knowledge is intertwined with the being who knows and this being is influenced by historical, cultural, and social constructions of gender and gender roles in societies. In this thesis, I draw on feminist critique of science, feminist science education, and the history of science, in particular biology as an educational discipline, to investigate the practices of higher education science in general and higher education biology in particular. Inspired by the work of Donna Haraway, Sandra Harding, and Evelyn Fox Keller as well as bell hooks, Judith Butler, and Sara Ahmed and critical feminist science education scholars, I deconstruct the myth that higher education biology is gender neutral. That is, I ask this question: Whose biology?

3.2.3 Figured worlds, communities of practice, and science identity

When children play, they give symbolic meaning to objects whose everyday meaning is suspended—bark becomes a plate, grass becomes spaghetti, and soil becomes parmesan cheese sprinkled on top. Tangible objects are turned into artifacts by the attribution of meaning (Vygotsky 1978); in this case, objects found in nature become food. Children learn to navigate rule-bound worlds by entering imaginary worlds through play. They might contextualise the plate of spaghetti as served at home or in a restaurant as parents feeding their children or as chefs and service staff serving customers. They might imagine and produce artifacts as props in imagined performances and activities. The idea of imagined worlds inform Holland et al.'s (1998) concept of figured worlds, which 'take shape within and grant shape to the coproduction of activities, discourse, performances and artifacts' (51). Figured worlds are also described as 'socially and culturally constructed realms of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others' (52). That is, figured worlds are socio-historic interpretations and imaginations of "as-if" worlds.

The concepts of figured worlds and communities of practice share the idea that identities from participants within form and are formed by interactions with the worlds and communities. As mentioned earlier, communities of practice as a social theory of learning is grounded in the idea that participants move from a peripheral participation towards a more central participation in the very practice of learning. Learning is conceptualised as a trajectory of participation, participation that takes on meaning in social worlds (Lave and Wenger 1991). Along these trajectories within sociocultural worlds, participants become different kinds of people, so learning is indivisibly intertwined with the construction of identity. Wenger (1998) emphasises that identity in learning is profoundly temporal and an ongoing process of negotiating of belonging and non-belonging in social landscapes of participation, as it is a complex process that involves 'doing, talking, thinking, feeling, and belonging' (56). Lave and Wenger (1991) as well as Wenger (1998) consider language acquisition to be part of identity trajectories and learning as well as discourse as shapers of practices and being shaped by practices. Discourses are considered 'material for negotiation of meaning and the formation of identities' that can be shared by multiple practices (Wenger 1998: 130) and communities of practice themselves to produce and reproduce discourses. Here, conceptualisations of communities of practice and figured worlds overlap.

Although both communities of practice and figured worlds emphasise the centrality of practice in the formation of worlds and communities, some theorists, especially Holland et al. (1998), embed the concept of figured worlds in social constructivist thought, acknowledging that 'selves are constructed

through the mediation of powerful discourses' (26) with identities being shaped by practice and discourse as well as 'with the aid of cultural resources' (285). Identities are made in and through participations in figured worlds 'in which particular characters and actors are recognized' (Holland et al. 1998: 52). This view also means that meaning is made in these worlds through negotiations and recognitions of cultural productions, and identities are made recognisable through the authoring of the self within. Here, discourse, communities of practice, and figured worlds are intertwined with science identity.

Recognition, competence, and performance are central to the concept of science identity as proposed by Carlone and Johnson (2007). These authors build on Gee's theory of identity (2000, 1999), the formation of identity through recognition in practice as described by Holland et al. (1998), as well as science as a community of practice (Lave and Wenger 1991; Wenger 1998). Hence, Carlone and Johnson (2007) bring together these intersecting theoretical perspectives and explicitly add the power dimensions of gender, race, and ethnicity to understand how science identity, especially in relation to notions of belonging and non-belonging, is negotiated.

In this thesis, I build on, expand, and combine the above-mentioned concepts in a variety of ways and to greater or lesser extent in the different articles. Although my primary focus lies on what identities and what identity trajectories are imagined as intelligible by students and teachers in worlds of higher education biology, I am also interested in how identities in biology form and are formed through imaginaries of figured worlds and overarching gendered discourse of science practice. To develop and apply a sensitivity for gendered processes at play, I draw on several theoretical concepts described in the following.

3.2.4 (Gendered) performativities and intelligible identities

Feminist theoretical perspectives on science and science critique form the foundation of this thesis, and I draw on different concepts that deepen the understanding of identity as an ongoing discursive and sociocultural process of negotiation.

Although identities are shaped by and shape rule-bound discourses and cultures, they are never entirely determined by culture and discourse through the agency that negotiates these (Butler 2007 [1990]). Therefore, Butler suggests moving from an epistemological account of identity to conceptualising identity in terms of signification of practices. Signification and resignification, in that sense, work through repetitions of cultural and discursive rules in practice that render some identities as intelligible and some as unintelligible. Butler argues:

> to understand identity as a practice, and as a signifying practice, is to understand culturally intelligible subjects as the resulting effects of a rule-bound discourse that inserts itself in the pervasive and mundane signifying acts of linguistic life. (2007 [1990]: 198)

This process of repetition is a regulating and regulated one, and agency, the possibility for change, is in itself regulated by the zones of possible variation from the rule-bound repetition. Butler is referring to the repetition of gender identities and the failed politics of naturalizing bodies in binary and compulsory heterosexual configurations. However, I argue that the theorisation of identity here applies to all identity political contexts as they find themselves in historical, cultural, and social structures of power.

The power in discourse produces privileged signifiers through repetition of norms; Butler argues that

> the 'performative' dimension of construction is precisely the forced reiteration of norms. In this sense, then, it is not only that there are constraints to performativity; rather, constraint calls to be rethought as the very condition of performativity. (2011 [1993]: 59)

In terms of figured worlds, this means that the rules found in the world condition possible performances and their recognitions. Here, I want to explicitly connect the performance in science identity to the performativity described by Butler. I consider performance in a performative sense, a performance of rule-bound norms, conditioned and therefore containing possible performances determined in possible variations, variations that are either still considered intelligible or no longer considered intelligible. This is even the case for performances of emotions. For example, Sara Ahmed (2004) argues that even emotions are performative, embedded in a cultural practice rather than a psychological state. The concept of intelligibility is strongly intertwined with the theorisation of the heterosexual matrix, inseparably linking gender and sexuality in a grid of cultural intelligibility that naturalises bodies, genders, and desires (Butler 2007 [1990]). Through the naturalisation of stable gender identities and heterosexual attraction, heterosexuality becomes culturally intelligible while rendering homosexuality as diverging from the norm—i.e. unintelligible (Gunnarsson Payne and Öhlander 2017). In this thesis, I draw on the concepts of intelligibility and performativity to allow for close connections of matters of identity along dimensions of power such as gender as well as other historically-, culturally-, and socially-shaped institutional identities such as *student* and *teacher* and *biologist* and *scientist*.

4 Methodology

An umbrella

It is the second time I rather spontaneously get asked to jump in as an examiner in a plant identification exam, outdoors. The exam is a walk including 15 stops where students have to identify up to three flowering plants, ferns, horsetails, mosses, and lichens. They get a piece of paper with a table on it and have to fill in the table with the plants' scientific names in the right order. Swedish common names don't count. Students are allowed to use a Swedish vegetation identification book, which most of them mainly use to look up the scientific names they are supposed to write because they only learned the Swedish names by heart. During the first examination round this year, I guided three students who were granted more time per stop than other students for different reasons. Seven rather than five minutes.

Two more minutes. An inclusion measure. Two minutes. An equity measure.

During the first examination walk, a massive thunderstorm rolled over the fields and forests throughout our 1.5-hour walk. Students were fighting their umbrellas in the wind to protect their paper and themselves from getting soaked, trying to look up scientific names in books so thick that they are hard to hold with one hand while standing or hovering under their umbrellas.

Pens and pencils fall. Papers rip. Umbrellas break. Students break.

When thunder and lightning indicated the storm to be right above us, I called the responsible person and asked if we really should continue.

His answer was yes. So we did.

Weeks later, a second examination round.

I again spontaneously get asked to supervise a student. It is one of the three students that had to repeat this exam. The student is nervous, even though they are knowledgeable and well equipped with rain gear, a baseball hat, transparent envelops to protect the examination paper from getting wet and ripping. And an umbrella. A big one. A new one.

The moment we start the exam, it starts raining buckets. Again.

Already at the first stop, it rains so much that there is no way to stay dry, keep the paper or the book from getting wet while using them at the same time. Again.

Since it is only the two of us this time, I ask if I can help by holding the student's umbrella.

They say yes.

A routine develops. We arrive at a stop. I show them the plants. I take over their umbrella. And follow the student's instructions. Sometimes we would walk up to the respective plants again. Sometimes, I would also hold the keying book. Sometimes, they ask me if what was written is actually readable.

Even with the holes punched into the wet paper with their pencil.

Scientific names. Punching holes.

Then we walk. And repeat.

Eventually, it rains so heavily that their glasses fog up while looking at and trying to identify a horsetail (*Equisetum*). Now they can neither see, nor read, nor write. I tell them I can hold on to all their belongings as they clean their glasses.

I can feel the student is getting frustrated. For a good reason. And I do, too. My feet are cold, my arms are heavy. I feel this is unfair. Especially for the student but even for myself. Yet, I know and see how much they have studied and want to pass this exam.

I can relate. And we continue. Until the end. Standing underneath their umbrella. Together. And I think about the irony of this. While standing underneath the student's umbrella.

An umbrella that says manpower.

Protecting ourselves from the rain underneath an umbrella brought me closer to a student than usual. A closeness that they and I negotiated in our roles as examiner, teacher, and student, a student who was older than me, a student with whom I had conversations about why they get more time than other students. A student that asked me to remind them to eat during the exam. A student that asked me to care.

The first exam story does not end after we continued. When coming back to meet the whole group and the other examiners, they have already started with the second part of the exam. Students getting unknown plans and keying them. Students sit spread out in a courtyard. Underneath their umbrellas, rain jacket hoods, trees, on benches, tables, brick walls, or the ground. Some of them with empty Tupperware boxes next to them. Focused. The three students and I come back and meet the person in charge. I know my group needs a break. He meets them and tells them to find themselves an

> empty spot and that the second part of the exam has already started. The student that I will meet again asks if they can have a break. The answer is, well you can do the exam first or eat first or do it at the same time.
>
> No lunch. No break. No bathroom. Only exam.
>
> It matters what methodologies we choose. Not only in our research, but especially in our teaching.

In this chapter, I map out the methodological traditions that this thesis is rooted in and describe in more detail the data collection and the analysis, as well as my analytical framework. Furthermore, I reflect on doing qualitative, reflexive, and ethical research.

4.1 Studying discourse and identity in higher education biology

4.1.1 Making use of language as discourse

In the theoretical framing, I have already begun to engage with ideas and definitions of discourse, emphasising that discourse is not only a theoretical perspective but also a methodological tool (Jørgensen and Phillips 2002). Discourse in its most simple form can mean 'any utterance or discrete piece of language' (Andermahr et al. 2000: 65); however, depending on the tradition(s) of departure, the term discourse can designate language in a variety of ways yet with the shared conceptual idea of language shaped and structured through and in social practices and discourse analysis to study these structures and patterns shaped in interactions (Jørgensen and Phillips 2002). Although complex and sometimes self-contradictory, Foucault's definitions of discourse as inherently connected to power have been influential in cultural theory development. The linguistic turn, differentiating structuralist and post-structuralist theory, moved perspectives on language from being an expressive 'vehicle of communication' to being a 'system with its own rules and constraints' (Mills 2004), a system that produces and reproduces structures of power (Foucault 1972). Critical discourse theory and analysis, as employed in this thesis, is grounded in theorisations of discursive practices to maintain ideological social effects through (re)productions of unequal relations of power (Jørgensen and Phillips 2002). Taking its point of departure from feminist critique and critical discourse theory, this work does not aim to be politically neutral, but rather, in line with critical discourse theory, it aims to uncover what and how discourses shape practices and maintain power relations in higher education biology.

4.1.2 Exploring identities and meanings in figured worlds through discourse analysis

Communicating through language, irrespective of it being visual, written, non-verbal, or verbal, goes beyond merely conveying information through speech. It is also a social act in interactions, so it matters who is communicating and how and what is communicated, both when communicating and when being communicated to. Hence, communication through language is an act that comprises different dimensions of saying, doing, and being and involves information, action, and identity (Gee 2014 [2011]). Identity is one of the central lenses in this thesis, used to study ways of being intertwined with ways of doing and knowing in figured worlds of higher education biology. To understand participants' identity work in the worlds they inhabit, how they relate to these worlds, shape and are shaped by these worlds, the very understandings and figurings of these worlds become interesting. In Paper I, I explored these taken-for-granted understandings of worlds, typical stories within, with the help of Gee's Figured Worlds Tool, which asks the reader the following:

> For any communication, ask what typical stories or figured worlds the words and phrases of the communication are assuming and inviting listeners to assume. What participants, activities, ways of interacting, forms of language, people, objects, environments, and institutions, as well as values, are in these figured worlds? (2014 [2011]: 177)

As with the example of playing restaurant in the theoretical framework section, where dishes are prepared, served, and consumed by different and certain participants in a certain spaces in environments, the Figured Worlds Tool makes these taken-for granted ideas visible. To focus on imaginaries of participants and their interactions, the ways of being and doing, I used Gee's Identities Building Tool:

> For any communication, ask what socially recognizable identity or identities the speaker is trying to enact or to get others to recognize. Ask also how the speaker's language treats other people's identities, what sorts of identities the speaker recognizes for others in relationship to his or her own. Ask, too, how the speaker is positioning others, what identities the speaker is "inviting" them to take up. (2014 [2011]: 116)

The Identities Building Tool focuses on how identities within figured worlds are enacted by participants and how different identities of the self and others relate to each other. Through a sensitivity for figured relationalities of enacted identities, one can make visible the hierarchical stratifications of what identities are more recognised than others within figured worlds.

Even in Papers II and IV, I employed Gee's (2014 [2011]) Figured Worlds Tool, where I pay particular attention to how teachers in their teaching statements and students, whom I interviewed, imagine participants in figured worlds of higher education biology, their acts, as well as activities, and ways of interacting that were described in a rather taken-for-granted manner.

In Paper III, I compare how students and teachers made meaning of and directed taken-for-granted and supposedly positive emotions such as enthusiasm and passion. Here, I was inspired by three of Gee's (2014 [2011]) discourse analytical building tasks, the Figured Worlds Tool and the Identities Building Tool as mentioned above, as well as the Situated Meaning Tool. The latter helped me to pay attention to the very meaning that is assigned to enthusiasm, passion, and interest. This tool focuses the analytical lens on "the specific meaning a word or utterance takes in specific context of use" (Gee 2014 [2011]: 157). I could thereby nuance how students and teachers made sense of these emotions in the context of higher education biology.

4.2 Data collections and analyses

The four papers presented in this thesis originate from three datasets. In this section, I will describe how the data were collected and analysed in the respective publications. In Papers I, II, and III, the data, in the form of students' study motivation texts, as well as teachers' teaching philosophy texts (i.e. teaching statements), were collected from populations at the same Swedish university. In Paper IV, I draw on interview data from semi-structured timeline interviews with students from a Swedish, British, and German university. Swedish participants were recruited from students who provided their study motivation texts, while students at the German and British university were recruited through independent and snowball sampling (see Table 2 for an overview over the data and the data analyses).

4.2.1 Paper I: Students' study motivations

The first data set originally comprised 55 study motivation texts from Swedish first-year students of different cohorts (2014-2018). These texts were written as part of a communication training programme that accompanies their undergraduate studies until graduation. It contains several tasks at different stages of their studies, from writing essays to oral presentations. A Swedish version of the original instructions can be found in Appendices A and B. As these texts were written in the context of communication training and not explicitly for research purposes, we recruited students through emails via the cohorts' mailing lists as well as through visiting a first-year lecture, where we were invited to inform the students about the project and possible participation in the pro-

ject. We asked students for their informed consent to use their study motivation texts in this PhD project as well as whether they would like to be contacted for future studies, surveys, and interviews (see Appendices C and D).

Table 2. Overview of the data and analysis of the four research papers included in this thesis.

Paper	Population	Description of the data	Analysis
I	Students at the Swedish university	Study motivation texts Essays written in the context of the first biology programme course, maximum of one A4 page, in Swedish	Initial open coding (Saldaña 2015) Discourse analysis inspired by Figured Worlds and Identities Building Tools (Gee 2014 [2011]) Statistical analysis
II	Teachers at the Swedish university	Teaching statements Essays written in the context of applications for professor positions, maximum of three A4 pages, in English and Swedish	Initial open coding (Saldaña 2015) Discourse analysis inspired by Figured Worlds Tool (Gee 2014 [2011])
III	Students and teachers at the Swedish university	Revisiting datasets from Paper I and II	Discourse analysis inspired by Gee's (2014 [2011]) building tasks focusing on emotions
IV	Students at the Swedish, German, and British university	Individual timeline interviews (Adriansen 2012) Interview transcripts in English, German, and Swedish	Initial thematic analysis (Braun and Clarke 2006) Deductive thematical analysis operationalizing science identity (Carlone and Johnson 2007) Discourse analysis inspired by Figured Worlds Tool (Gee 2014 [2011]) Re-evaluating initial themes iteratively

The study motivation texts were anonymised and labelled with the letter A and a random number between 1 and 99 before analysis. In addition, all indicators of gender identity found in the texts were removed to focus the analysis on the students' imaginaries and reduce my own gendered biases during the analysis. In a first open coding step, the data were explored for analytical leads (Saldaña 2015) before conducting a discourse analysis applying Gee's Figured Worlds and Identities Building Tool (Gee 2014 [2011]).

Figured worlds, as mentioned above, are collectively formed socially and culturally constructed interpretive imaginaries of social practice that become embodied over time and through participation in their practices (Holland et al. 1998). In this thesis, I use Gee's (2014 [2011]) discourse analysis tools that Gee operationalised for the concept of figured worlds (Figured Worlds Tool) and theorisations of identity (Identities Building Tool). The Identities Building Tool asks what enactments of identity or identities a person recognises and therefore prompts the analysis to focus on the enactment (i.e. the performance of identities as well as the recognition of identities). This tool also includes a reciprocity of 'what sorts of identities the speaker recognizes for others in relationship to his or her own' as well as allows for a sensitivity towards how identities are positioned and what identities are invited (Gee 2014 [2011]: 116). The Figured Worlds Tool goes beyond these enactments of identity and focuses on the taken-for-granted ideas that inform the very enactments (Gee 2014 [2011])—i.e. what is assumed by the speaker and what are others invited to assume. The Figured Worlds Tool consequently brought the focus to the environments, figured worlds, or typical stories imagined by participants in which they themselves negotiate their identities.

This analysis made it possible to combine the concept of figured worlds (Holland et al. 1998) and science identity (Carlone and Johnson 2007)—what competences and performances were recognized as typical in worlds of higher education biology. It yielded two imagined identity trajectories: the straight biology path and the backpacking biology path. After describing these two imagined identity trajectories and categorising the study motivation texts as either or both, the data were revisited. Disclosing students' gender for quantitative analysis, we used Pearson's chi-square test of statistical independence in R to analyse differences in frequencies of students of a certain entry (natural science or social science) or gender in relation to the three trajectory categories.

4.2.2 Paper II: Teachers' teaching statements

The second data set was collected in two steps (2017 and 2020) and originated from teachers' applications for university teaching positions in the biology section of the Swedish university. Applicants for assistant, associate, and full professor positions are asked to write their teaching philosophy or a teaching statement essay. As these texts are part of the application process, they are

publicly available documents (*offentliga handlingar*). The texts were requested from the Swedish university's staff recruitment unit. For the 30 advertised positions between 2012 and 2019, we collected applications from those candidates who were shortlisted and called for interviews—the interview group. The full data set yielded 94 applications. In terms of the rational for this kind of data collection, the interview group was invited to or at least not excluded from interviews because of their teaching statements. Hence, their texts were considered appropriate by the hiring committee. For analysis, the texts were extracted from the full applications, sorted by type of position, and anonymised for analysis.

In an initial and open coding step, the three categories of assistant, associate, and full professor were analysed separately to find common themes and gain an overview of the teaching statements (Saldaña 2015). Since no thematic differences among the three teacher categories (assistant, associate, and full professors) were found, the data set was treated as one in the following analysis. The theory-driven discursive analysis was inspired by Gee's Figured Worlds Tool (2014 [2011]). Gee's Figured Worlds Tool also operationalised Holland et al.'s (1998) concept of figured worlds and in combination with further theoretical concepts such as science identity (Carlone and Johnson 2007) and intelligibility (Butler 2011 [1993]), which helped visualise the identities imagined as intelligible by the teachers for both themselves and the students they encounter in figured worlds of higher education biology.

4.2.3 Paper III: Comparing students' and teachers' perspectives

The third article is empirically rooted in the same material as Paper I and Paper II. These two papers examined the study motivation texts of 55 first-year biology students. In addition, 94 teaching philosophy texts from applicants for university teaching positions in biology were analysed. For this comparative study, this empirical material was revisited.

To (re)familiarise myself with the data, the articles and essays were initially (re)visited with particular sensitivity to how students and teachers imagine the world of higher education biology. Next, I focused on how teachers and students, along the four previously described identities (research science teacher, facilitating science teachers, straight biology path, and backpacking biology path), made meaning and directed emotions such as enthusiasm and passion in the context of higher education biology. Combining the Situated Meaning, Identities Building, and Figured Worlds Tool (Gee 2014 [2011]) made it possible to first explore the very meanings and directions of enthusiasm, passion, and interest to then compare them amongst the four categories.

4.2.4 Paper IV: Interviews with students from the Swedish, German, and British university

The final article included in this thesis is empirically grounded in interviews conducted with students from a Swedish university as well as interviews with students from a German and a British university (see Table 3 for information about gender distribution). The students from the Swedish university were recruited from the group of students who gave consent to use their study motivation texts (used in Papers I and III). I contacted them via the provided email addresses. The German and British university students were recruited through a variety of methods. At the German university, I recruited students with the help of the director of studies who shared the call via mailing lists. Furthermore, I contacted the local student council to share the information on their formal and informal channels as well as posted the call on their social media page. In addition, participants were recruited through personal contacts from a PhD student, who was working at the German university, as well as through snowballing initiated by some participants. At the British university, a teacher helped recruit students by sharing the call in email lists and personally inviting students. Furthermore, students were recruited when sharing information in two seminars given by myself at the British university and through snowballing by some participants. Due to the recruitment method, students from early Bachelor's to near-end Master's level were interviewed.

Semi-structured timeline interviews (Adriansen 2012) were performed in person at the British (October 2019) and the German (November 2019) university and online with students from the Swedish university (February/March 2021). The timeline interviews were divided into three chronological parts: the time before the students started their studies; during their studies; and their future plans and expectations. These were accompanied by a variety of questions (see interview guide in English in Appendix E, in German in Appendix F, and in Swedish in Appendix G). During the physical interviews, students were provided with white paper and coloured pens to construct their timelines in material form. During the online interviews, students were asked to have paper and pens at hand and to share their timelines by sending photos via email. Students provided written informed consent to participate in the study at the beginning of each interview (see informed consent form in English in Appendix H used for students at the German and British university). For the Swedish interviews, which were conducted remotely and recorded, students gave their informed consent verbally after reading the informed consent form at the beginning of the interview (see informed consent form in Appendix I), which was recorded.

Table 2. Overview of the interviews conducted at the British, German, and Swedish university

	The British university	The German university	The Swedish university
female students	8	9	2
non-binary students	0	0	2
male students	3	2	1
total	11	11	5

Interview questions were developed as both closed questions, which were then followed-up, and open questions (Harvey 2011). The latter prompted reflections and allowed students to develop their thoughts and feelings as well as to discuss their experiences and perspectives as I wanted to capture the most salient items (Weller et al. 2018). Although some questions (e.g. How would you introduce yourself to other people?) were aimed at initiating imaginative reflections, other questions (e.g. What were the most impactful events that have influenced you to apply for the biology programme? And Were there important people that influenced your study choice?) were used to prompt reflections on events and people they remembered and/or considered having been impactful in hindsight. Therefore, these interviews comprise a sample of what the students remembered as significant, as well as what they recognised along their trajectories and in relation to what they imagined me as the interviewer to recognise, discourses, values, and identities (re)produced in interactions. Although developing a timeline was at the centre of all interviews, the Swedish students were also asked to read and reflect on their study motivation texts. Several questions aimed at supporting the students in their reflections and to facilitate relating to their former selves' experiences and expectations—e.g. What are your thoughts now after you have read the text? (*Vad är dina tankar nu efter att du har läst din text?*) and What would you tell your old self about the text now that you have come so far in your studies? (*Vad skulle du säga till ditt gamla jag om texten nu när du har kommit så långt i dina studier?*). The interviews were conducted in the official language of the respective country (English, German, and Swedish), recorded and transcribed using AI-based transcription software available for all three languages. The transcripts were then revisited and manually revised.

Although no questions explicitly asked students to relate to sensitive personal data such as religious or similar beliefs, sexual orientation, political opinion, and physical or mental health, students at the British and German universities volunteered some of these aspects in relation to their experiences in higher education biology. As I neither wanted to be forced to interrupt the students from sharing their stories nor wanted to exclude what they considered important to share while at the same time relating to the university's ongoing

GDPR (General Data Protection Regulation) work, an ethical review was filed before interviewing the Swedish students (2020-04470).

While all interviews inform the analysis in Paper IV, six anonymized transcripts were chosen by the first author after preliminary thematic analysis (Braun and Clarke 2006) for iteratively analysis in the research group. These six interviews (two from each university) were particularly rich and students explicitly and implicitly negotiate themes found across the data set and gender categories.

In a first exploratory open coding (Saldaña 2015), we familiarised ourselves with the six interviews and explored overarching themes (Braun and Clarke 2006). We then operationalised Carlone and Johnson's (2007) three pillars of science identity to gain an overview of what competences and performances the students understood as recognised for themselves and others in higher education biology. These preliminary findings indicated negotiations of participation in fieldwork, private commitments to academic tasks, work experience in the industry, and negotiations of being or not being a biologist, a researcher, and/or a scientist. Based on these preliminary findings, we used the Figured Worlds Tool (Gee 2014 [2011]) to focus on what the students considered "typical" through which we could display and nuance tensions between identities available for selves and others in formal and informal, private and professional, and academic and non-academic worlds. In a final step, we returned to the initial themes and the interview data to iteratively refine the findings and map how three successful female students negotiated these imaginaries.

Collecting gendered data, risking to overlook gender identities

In Paper I, students' gender identity was inferred based on their Swedish social security number (*personnummer*). In Paper II, the teachers' gender identity was either identified through their Swedish social security number if available, inferred based on explicit information on their gender identity in their application, or in rare cases by searching for indicators of their gender identity on professional websites. In all searches, no indicators of gender non-binary or genderqueer identities could be found. It is here important to mention, however, that the Swedish social security number up until today only indicates a person to either be female or male[6]. Hence, all data used in Papers I, II, and consequently also III were categorised as either female or male. This yields

[6] In Sweden, the legal gender (*juridiskt kön*) assigned at birth is visible in one's social security number https://www.skatteverket.se/privat/folkbokforing/personnummerochsamordningsnummer.4.3810a01c150939e893f18c29.html?q=personnummer. While a motion has been submitted to the Swedish parliament, *riksdagen*, to introduce a third legal gender as well as gender-neutral social security number (motion 2019/20:3316: https://www.riksdagen.se/sv/dokument-lagar/dokument/motion/ett-tredje-juridiskt-kon-och-konsneutrala_H7023316), until today, one cannot register a legal gender other than woman or man.

the risk of having overlooked gender identities other than identifications as female and male in the material. Learning from the above-mentioned structural difficulties, I had informal and formal conversations about gender identity with participants during data collection for Paper IV.

4.3 Reflections on studying discourse and identity in higher education biology

In this section, I will include both reflections on conducting reflexive research as well as reflections on conducting ethical research. These reflections have continuously been revisited during the project work in relation to what it means to do research on practices deeply engrained in research—i.e. doing research as a practice of and on research institutions.

4.3.1 Conducting reflexive research

It is not easy to be both an insider and an outsider as well as an in-between-sider or sometimes even a no-sider. Having a background in and academic degrees in higher education biology as well as having been a teaching assistant and a tutor for many years informed the very development of this study and shaped the stories that I use to tell stories (Haraway 2016). Although these embodied and lived experiences, memories, and subjectivities shaped this project and made it unique, opened doors, and enabled me to explore certain paths, it also created bumps and walls (Ahmed 2016). Reflecting on and practicing reflexivity, the circularity of effect and cause, cause and effect, has been an ongoing learning process in actions and through interactions. I do not assume knowledge can be value-neutral and objective—i.e. I assume knowledge is situated (Haraway 1988), which is the theoretical and epistemological backbone of this thesis. Reflecting on my own positionality, reflecting on my own subjectivities, reflecting on power in interactions, and reflecting on the power of labelling, I believe I have the obligation as a researcher to make myself accountable (Koobak and Thapar-Björkert 2014). Critical feminist research makes space for storytelling yet requires transparency about the stories that tell stories. In my research, in my interactions with others, and in my thesis, I try to practice transparent reflexivity, share who I am, and reflect on how who I am influences what I do. I do not want to pretend that it has been easy, and I am aware that I have failed at reflexivity, (re)producing the very norms that I aim to dismantle, using the grammar that contributes to the very (re)production of these norms (Hemmings 2011). Throughout this research process, I have learned about some of my biases, my languages, and my values and how these influence my knowledge productions, but there is so much more to be learned. Therefore, I have worked to develop an authentic and reflexive voice

to communicate my work, so I decided to include autoethnographical accounts to build bridges between the researched and the researcher.

4.3.2 Conducting ethical research

I believe that reflecting on one's own positionality and subjectivity is strongly intertwined with doings of ethical research. Moving from a rather quantitative discipline, biology, to a human-experience, an identity-centred project situated in gender studies, moved my focus from the centrality of research design to the centrality of ethical considerations. Although my research has followed guidelines for research integrity and good research practice, formally applying for ethical approval (2020-04470) in the local and national code of conduct, reflecting on what this research means for all beings that it involves has been central to my research process. This project aims to explore identities in relation to norms and values in higher education biology, norms and values that can both include and exclude. Hence, this subject is an emotional one, one that not only includes intellectualised power dimensions of, for example, gender, but also includes feelings and emotions that cannot be put into words. On the one hand, formalised measures were put into place to acknowledge the integrity of the participants. Students were informed about the project and about what it means to participate. They were asked for informed consent to use their study motivation text and their interview responses (Appendices C, D, H, and I). Throughout interactions, I have aimed at disclosing possibilities for agency in the research process to work against feelings of limited agency—e.g. disclosure of personal information when sharing it with spaces outside of one's control can easily lead to discomfort. Hence, respect for participants' anonymity outside the research team has been indispensable and an ambition in all communications. When writing about and when talking to participants about their perspectives and experiences, I tried to accommodate the spectrum of feelings expressed. Although the interviews did not explicitly ask the participants to share sensitive matters such as health details, gender identity, and political attitude, most participants voluntarily shared some of these issues, which shows how strongly identity is entangled in complex personal and political matters.

As this research aims to transgress walls of exclusion from practices, I consider learning how to practice inclusion and practicing inclusion in an inherently exclusive practice to be important when doing research in general and even more so when doing this kind of research. It has been central to my research to not "research others" but research together. Moreover, I believe research should benefit all the participants rather than just the researcher. I have put this belief into practice by inviting participants and collaborators to seminars about my work, inviting them to ask me questions, genuinely and personally answering them, and inviting people to actively participate in these discussions and share knowledge to learn with and from each other. Although I

learned about the theoretical and analytical power of care when developing this research project, the ethics of feminist care have been a sounding board for my doings in this project (De Laine 2000; Edwards and Mauthner 2002; Robinson 2011; Simons and Usher 2012).

5 Findings

Being moved

I come out of the subway in this throng of people in their warm, fancy coats, laptop bags and with their wireless headphones. One cannot stop but follow the flow of the line that walks up the escalators.

Escalators. Something that is already moving. Something that moves you. Something that forms a line or two. Ever repeating. Bringing you up or down. You can't really stop.

I feel like being part of an avalanche of people moving uphill rather than downhill. Turning left, yet another escalator. And then the space opens up. The first thing one can see is the golden symbol of the university. Huge above the square, not to be missed when exiting the subway station. On buildings out of red bricks. In-between an aisle of cobble stones. Uphill. Vines of plants growing up the brick walls. No leaves, naked. It is still winter.

I continue walking up the hill to another square. There you can choose to go left or right. To the right, there is a deep ally, dark and narrow, between even more red brick buildings. Dark-red, almost purple bricks. Left, it is brighter. Industrial buildings in the end of a broad cobblestone road valley.

I choose the information sign just in the middle before choosing a path. Trying to find the library. I find the library building on the map, standing there. The sun behind me places this shadow of a human onto the blue and white map of the campus.

I have to go through the dark alley, joining a new avalanche of people that just came out of the subway station. Again. A new human avalanche every three minutes. There is no possibility to slow down, turn around and look at the bricks, the plants, the cobblestones. Once you decided, you are directed. The avalanche pulls me in, swallows me, makes me adjust to its pace. Until I reach the library, where it spits me out.

The swing doors of the library are out of order. Taped densely in 'do not cross, under construction' tape. I am insecure about the glass door next to it to open to the entrance hall that I can see through the very glass. I try. It is open. I enter a space with a huge piece of modern art above me. In the

> centre yet almost so big that it is not noticeable. On my right. The library. The North Gallery.
>
> It is an old factory building, the former open courtyard covered up with a ceiling that is held by huge metal pillars. The outside made into the inside. The space between the new glass roof and the red purple bricks is bridged by glass windows. Huge windows, filling the whole space with light. There are reading islands. One lonely one with a real tree. I sit down next to it. Slow down.

In this section, I present the research questions for each study and summarise the findings presented in the four research papers.

5.1 Paper I

In Paper I, we explored early undergraduate students' imagined identity trajectories in the figured world of higher education biology and asked:

- I.1 How do students in their first undergraduate biology course imagine and figure the world of higher education biology in their study motivation texts?
- I.2 What stories and identity trajectories do the students imagine as typical and non-typical?
- I.3 How do the students relate themselves to these imagined typical stories and trajectories?

We found two imagined identity trajectories in the world of first-year undergraduate students at the Swedish university: the straight biology path and the backpacking biology path. The straight biology path students imagined a scientific child with an inherent interest for nature and talent for science who develops into a self-evident science student who understands scientific processes and eventually becomes an academic science student pursuing an academic research career. They imagined narrow interests and a proclivity to natural sciences to be intelligible and recognised, naturally given and required. Backpacking biology path students recognise the breadth of biology as a resource when exploring the discipline for possible futures. Furthermore, they value transgressing disciplinary boarders and express different ways of combining biology with disciplines and activities inside and outside the academic world. These students imagine (biology) knowledge put in a backpack for future use. Although they figure themselves in ways that we described as explorer and transdisciplinary students, exploring biology as a broad discipline and transgressing disciplinary boundaries, they also talk about themselves as winding students, students with winding trajectories in relation to a norm of

"straight" trajectories into science and biology. They explicitly talk about themselves as not being a certain kind of person. It is these negotiations of not being a certain kind of person that display imagined norms within figured worlds of higher education biology. When analysing the distribution of students drawing on backpacking biology path, straight biology path, and both narratives, we found female students tended to draw on backpacking imaginaries and male students tended to draw on straight biology path narratives. Furthermore, the male students often explicitly expressed ideas of inherent talent, brilliance, and narrow interests on straight paths.

The findings in Paper I indicate that first-year biology students negotiate their identities in relation to larger discursive norms of doing science. In particular, but not exclusively female students, imagined alternatives to these normative imaginaries, negotiating alternatives to the imagined generally shared typical stories present in worlds of higher education biology. Although the project departed from a strong focus on imagined intelligible identities in higher education biology as a discipline, imaginaries of science, kinds of scientific knowledge, and ways of scientific doings in worlds of higher education biology as well as their temporalities came into focus.

This article suggests higher education biology is a natural science discipline, which is influenced by overarching norms of doing science, such as smartness, talent, and rationality, qualities historically associated with the mind and masculinity (Gilbert 2001; Keller 1985). However, these norms are also contested. Therefore, this study focuses on imagined intelligible identities to make visible the diverse ways students imagine higher education trajectories. It also allows for analyses of the entanglement between imagined identity pasts, presents, and futures in biology with gendered norms of being in and doing science, providing evidence for dismantling and problematising an assumed absence of gendered disparities in higher education biology.

5.2 Paper II

In Paper II, we explored how university biology teachers at the same Swedish university as the students in Paper I figure worlds of higher education biology and negotiate imagined intelligible identities within:

- II.1 What intelligible identities do teachers imagine for themselves and others?
- II.2 What overarching ideas are reproduced or improvised from these imagined intelligible identities?
- II.3 How can teachers' reproductions and improvisations be understood in relation to masculine norms of scientific practice?

In Paper II, we described two imagined intelligible identities—the research science teacher and the facilitating science teacher. Research science teachers believe that the transmission of knowledge and enthusiasm were central to teaching. They value transmitting and infusing students with (good) science and aim to recruit (good) students into research careers. Research science teachers consider scientific practices to be an elite practice and a teaching position as the gilt edge of a scientist's life, a practice that is part of but not central to their activities as scientists. They consider active scientists and researchers to be good teachers through their very research competence. In contrast, facilitating science teachers imagine teaching to be an act that supports students in the process of becoming independent learners and thinkers. They consider learning spaces to be interactive, learning to happen in interactions, and acknowledge interdisciplinary knowledge productions. Facilitating science teachers explicitly reject commonly known and valued teacher goals to recruit students into research and want to support the students as they shape their own education. They negotiate and disentangle their roles as teacher and researcher; rather than imagining research competence making them good teachers, they see teaching as a skill to be learned and developed like any other skill such as research and scientific knowledge production.

This study illustrates how overarching imaginaries of research and science act as discursive anchor points from which university biology teachers negotiate their identities. For research science teachers, biology, science, and research become equated, so learning and teaching biology are intertwined with hegemonic imaginaries about doing science and imaginaries of ultimate competence held by researchers. However, we can also see how facilitating science teachers, while being aware of these hegemonic imaginaries and relating to science as a discursive anchor point, improvise alternative imaginaries of being and doing in figured worlds of higher education biology. It is here tensions between research as a masculine-coded practice and teaching as a feminine-coded practice emerge within biology, a supposedly gender-neutral discipline. Research science teachers imagine hierarchical positionings of, as bell hooks phrases it, an 'all-knowing, silent interrogator' (1994: 21) versus a less-knowledgeable student who, once enculturated and therefore recognised as knowledgeable, is recruited into the very practice. An imaginary of being all-knowing, however, does not leave space for research science teachers to position themselves as learners, neither as learners of teaching nor as learners in interactions with students. Facilitating science teachers are still aware of and negotiate the dominance of research, yet they do not put research and teaching competences on a par and therefore liberate themselves from the centrality of research to inform all higher education biology practices. They make it possible to position themselves as learners, which, together with improvisations from hegemonic norms, creates possibilities for change.

Paper II provides further empirical evidence for the presence of hegemonic masculine norms in higher education biology and science and indicates how

university teachers negotiate these overarching hegemonic science discourses in relation to gendered practices of research and teaching. The empirical material in this study, the teaching statements, were written by teachers who were invited for interviews and many of them were offered a teaching position at the Swedish university. Therefore, they were given the power, based on their philosophy, to recruit students into biology participation. Hence, while providing insights into what ways of being, doing, and knowing are recognised by higher education biology teachers, this study also, through the very material used, visualises potential causes of a circular, generation-transgressing reproduction of hegemonic, masculine, and exclusive norms of doing science, which contributes to the inclusion of some and exclusion of others in higher education biology.

5.3 Paper III

The first two papers uncovered implicitly or explicitly negotiated ideas about interest, passion, and enthusiasm. In Paper III, I revisit the data from Paper I (students' study motivation texts) and Paper II (teachers' teaching statements) and focus on how these emotions were made sense of and directed by students and teachers along the previously described identity categories (research science teacher, facilitating science teacher, straight biology path, and backpacking biology path). Here, I build on a communities of practice framework, learning as a social practice that connects making meaning, building identities, and feeling a sense of belonging. Understanding emotions as part of learning and becoming, Paper III asks:

III.1 How do university biology students and teachers make meaning of and direct enthusiasm, passion, and interest?

III.2 What shared and colliding meanings of these emotions can be found and how do they relate to each other?

In this paper, I show that students and teachers make sense of enthusiasm, passion, and interest in diverse ways and could thereby challenge ideas of them being collectively understood and hence inherently positive and reinforcing. When comparing the meanings made as well as their directions, I found overlaps and tensions among students and teachers. On the one hand, emotions explicitly directed at research were valued by research science teachers and straight biology path students in practices of higher education biology. On the other hand, these meanings were challenged by broader meanings that reach beyond objects associated with scientific practice as understood by facilitating science teachers and backpacking biology path students. I discuss

how facilitating science teachers, while recognizing broader meanings of emotions, have the potential to broaden participation in higher education biology practice, as they allow both straight biology path students' emotional focus on research as well as enthusiasms, passions, and interests that go beyond a research context as shown by backpacking biology path students. Facilitating science teachers thereby build larger spaces of legitimate participation in which students can develop feelings of belonging to the practice. I also point out that recognizing only certain meanings and directions of emotions carries the risk of limiting students' identity work and hence hinder the development of a feeling of belonging. Considering the recognition of emotions as important in the process of developing a sense of belonging to and in communities of practice, these findings indicate spaces of friction contributing to processes of in- and exclusion.

5.4 Paper IV

Paper IV is empirically grounded in 27 semi-structured timeline interviews with higher education biology students from three European universities—one in Sweden, one in the UK, and one in Germany. Although the analysis was informed by all 27 interviews, we focused on a subset of six interviews with students who considered themselves to be successful and share the goal of pursuing a PhD in biology. To explore the biology students' identity work, we asked the following two questions:

IV.1 What implicit and explicit typical ways of being and doing do students imagine within the world of higher education biology?

IV.2 How do students negotiate themselves in relation to these imaginaries and experience, assent, and dissent with these imaginaries when doing identity work?

Based on the six interviews, we mapped three imaginaries of typical ways of being and doing in worlds of higher education biology. In the first imaginary, *showing dedication through sacrifice*, students understood participation in higher education biology to require compromising on, for example, performances of identity and personal aspirations, sacrificing free time and one's health because of heavy workloads or taking strategically sensible courses rather than courses of interest. Underlying this imaginary is the idea that one has to compromise to succeed. An imaginary of *being forced to fake it to make it* arose from students negotiating tensions between their own competences and performances in relation to what they imagine has to be known and accomplished to legitimately participate in biology and science practices. Lastly, students related to imaginaries of *surviving of/as the fittest*, negotiating taken-

for-granted academic sorting processes in competitive environments that require hard work and the right kind of academic dedication. How these imaginaries were negotiated were mapped out in more detail along three female student cases, sampled from the six interviews. While these negotiations were not unique to the three female students, they were reflected in particularly articulate ways. Displaying how students draw on and challenge the aforementioned imaginaries, we were able to show the tensions in their negotiations, showing both familiarity with as well as reluctance towards what is considered typical in worlds of higher education biology. Based on these tensions we propose that the successful biology students in our study have learned to navigate normative practices, but struggle to fully embrace these norms; they are successful *despite* needing to relate to hegemonic imaginaries of what it means to do science.

6 Discussions

Introducing oneself

> When teaching my first biology course as a PhD student, I introduced myself as a PhD student in gender studies to first-year biology undergraduates. While I was rather enthusiastic about my new role and project, I quickly noticed that students would approach my fellow teaching assistants, biology PhD students, rather than me if they had questions relating to biology. It wasn't until two weeks into the course that I started being recognised as knowledgeable in biology and was approached by the students. A recognition of knowledgeability actively established through both performances of being a biologist and displays of my biology competences. I had introduced myself as an outsider within and I needed to work to become recognised as an insider. In the subsequent years, I would introduce myself as a biologist, highlighting my background in biology, doing a project in gender studies on higher education biology. I introduced myself as an insider. Insideness and outsideness were established through an introduction.

In this part, I return to the overarching aims of my thesis, which were to challenge imaginaries of biology as a gender-neutral natural science discipline through explorations of students' and teachers' identity work. In this process, I also wanted to understand (re)productions of inclusive and exclusive higher education biology cultures. Although more work that attends to these complex questions is needed, I will discuss imaginaries that occur across the studies included in this thesis to suggest how biology as a natural science discipline is embedded in worlds of doing science and how participants of these worlds are directed into or out of higher education biology.

6.1 Challenging straightness

This thesis is empirically grounded in study motivation texts as well as teaching philosophy statements written for purposes other than the studies that they inform. In Paper I, the study motivation texts were written by students at the beginning of their biology studies with the goal of having them reflect on their own study choice and aspirations. They were also used as a starting point for mentoring from and with a university biology teacher. Therefore, the study

motivation texts are not only independent reflections without any direction as they are directed at the teacher, a person recognised as a legitimate participant in the biology practice, but also have the aim of recognition. The texts become statements of value, displaying competences and performances (Paper I and Paper II), and emotions (Paper III), which are considered recognised. The teachers' texts, embedded in their application for teaching positions, are even more directed at being recognised as a professional biologist suitable for the advertised position. The texts are directed at the evaluation committee with the aim of being recognised as a legitimate candidate; hence, they exhibit the very values that the teachers have been enculturated into and that they imagined as being recognised in higher education biology. Consequently, both the students' and the teachers' texts display imaginaries of what is valued in worlds of higher education biology, what is understood as shared understandings of ways of doing, *practice*, and ways of being, *identities*, within. Through interviews with students at the three European universities (Paper IV), I explored what ways of doing and being students across higher education biology environments imagine as recognised as well as how they negotiated themselves in relation to these imaginaries. As these students have participated in higher education biology practices, they have experienced enculturation into the cultures, which influenced their identity work.

In the papers included in this work, I show how students and teachers imagine different ways of being in worlds of higher education biology. Some of these ways of being are taken-for-granted, implicitly or explicitly narrated as the norm, in line with what is imagined as the common way, a hegemonic way, of being in the world of higher education biology. Straight path students imagine an inclination for science and a straight path into a research career (Paper I). Similarly, research science teachers imagine their competence as researchers to make them competent teachers of future researchers (Paper II). Furthermore, emotions like enthusiasm and passion about research in general and about what one researches in particular are understood as central to higher education biology and science practice (Paper III). Finally, students imagined that doing science required dedication and sacrifice and participating in higher education biology and science were driven by competition. High levels of competence were also understood as the norm and consequently learning biology felt like "faking" legitimate participation (Paper IV). These imaginaries can be understood as hegemonic cultural constructions that constitute worlds of higher education biology, cultural narratives about what it takes to participate in these worlds in intelligible and recognised ways.

These findings revealed imaginaries associated with masculinity and maleness along a mind/body split are negotiated by students and teachers in higher education biology. This includes imaginaries of linear trajectories, ideas of raw talent, inclination to science privileging research over teaching, and a privileging of mind over body (e.g. Haraway 1988; Harding 1986, 1991; Kelly

1985; Lloyd 1993 [1984]; Mendick et al. 2017; Ottemo et al. 2021; Scantlebury and Baker, 2007). Hence the papers show that, as with physics, biology is not a culture of no culture (e.g. Gonsalves and Danielsson, 2020; Ottemo et al. 2021 referring to Traweek 1988).

At the same time, these dominant cultural narratives of being in the world are opposed and challenged by both students and teachers who, while showing familiarity with the dominant culture and therefore the underlining hegemonic position of the dominate culture, improvise ways to challenge the dominant cultural narratives. The students who chose a meandering rather than a straight path understood they could follow their diverse interests, collecting interdisciplinary knowledge along this winding educational path (Paper I). The teachers who opposed the idea that researchers are the ultimate knowers understood teaching as less about the transmission of scientific knowledge than about a process that focuses on students' interests and development (Paper II). Enthusiasm directed at research is countered by enthusiasms directed at teaching and students' achievements, as well as by broad passions and interests beyond research and science (Paper III). In addition, successful biology students across European contexts considered themselves successful despite having to negotiate dominant cultural imaginaries during their education and through their continued participation have the possibility to change cultures in the present and future (Paper IV).

Previous research shows that biology is stereotyped as less difficult (Bruun et al. 2018), requiring less brilliance (Leslie et al. 2015), and being easier to identify with and broader (Chen et al. 2022) than physics, a "hard" science or 'real science' (Danielsson et al. 2016). Biology has been described as a "soft" science, a "feminised" science, a science that e.g. in an evolutionary biology perspective needs to account for the very activities scientists do in their research, a perspective that challenges the imaginaries of scientific practice as purely objective (Harding 1986). Biology is often understood as the antipode to physics on a spectrum from feminine-coded to masculine-coded natural science disciplines, biology-chemistry-physics (e.g. Bruun et al. 2018; Eaton et al. 2020; Hazari et al. 2013). Similarly, Ottemo et al. (2021) suggests that reasoning along lines of the mind/body split are particularly relevant for subjects that privilege the mind over the body such as physics. This thesis demonstrates that while being subtle and requiring complex analyses, biology is, indeed, influenced by gendered ideas about science practice along splits of mind and body.

With this qualitative work, I make visible mind and body splits especially when biology becomes associated with science and research that reproduce 'linear and narrow career paths associated with masculinity' (Mendick et al. 2017: 482) in students' and teachers' imaginaries of what it means to do biology. Biology, therefore, is neither culture-free nor gender-neutral even though discourses as well as a numerical female biases on undergraduate level might have led to assumptions about gender neutrality (Eddy et al. 2014). At the

same time, I moved beyond these dominant and masculine models, which contribute to a simplification of the 'leaky pipeline' problem (Mendick et al. 2017). This simplification, which bears the risk of solely focusing on in- and exclusion based on factors outside the practice (e.g. family planning) rather than in- and exclusion processes within the very practice (like exclusive norms of participation). Gendered processes influencing participation in higher education biology are subtle and intertwined with hegemonic, elitist, and meritocratic imaginaries of science and research; they are present, not absent.

6.2 Research as orientation, science as directive

Prominent throughout this project and in all papers presented in this thesis are negotiations of being in biology as a discipline and how they are entangled with negotiations of science as a practice, research as a process of inquiry, and what it means to learn and teach *science* rather than *biology*. Students' and teachers' negotiations have different orientations, not only orientations towards but also orientations away from ways of being and doing biology, science, and research. In Paper I, students already at the beginning of their enculturation into higher education biology imagine their biology paths to be straight, oriented towards science and research goals. This is countered by students imagining winding orientations, explorations of possibilities. However, straight orientations were understood as the norm, othering other, and explorative orientations. University teachers negotiated themselves in line with research science cultures—i.e. research as elite, research as the goal that students should focus on, teaching how to do research as researchers, transmitting knowledge, and sharing enthusiasm for research and science (Paper II). Enthusiasm towards research is what other enthusiasms are measured against (Paper III). These ideas are explicitly opposed by other teachers who, despite being aware of the research-centeredness, want to support students in finding their own orientations, shaping their own educations. Students in later stages of their university biology education were oriented by ideas about science: science and research as a competitive, meritocratic environment, dedication to science being displayed through sacrifice. These imaginaries position science and research at the centre of the practice, identities negotiated in relation to these imaginaries.

Nancy Brickhouse and colleagues (2000) describe two problems with research scientists being the standard for science education and the identity that students are directed towards. Although Brickhouse and colleagues were discussing this issue in the context of 7th grade science education, these problems can also be transferred to undergraduate higher science education in general and in this case to higher education biology. First, the authors claim that research science practice is too distant and rather irrelevant to students (Brick-

house et al. 2000). This distance becomes visible in how the backpacking biology path students (Paper I) imagined their paths not necessarily leading to research. Their imaginaries conjure up the breadth of biology, learning about all the facets of the discipline and its interdisciplinarities. Forging students' identities towards research as the central practice of higher education biology already on undergraduate level, an identity that is not in line with the backpacking biology path associated with students' initial expectations and aspirations, risks directing them away from the practice of biology. Backpacking biology path students understand their undergraduate education as a way to orient themselves and some explicitly highlight hoping that they soon will feel 'home' in the programme, meaning that they, too, negotiate to stay in science. However, meeting narrow recognitions places the risk of losing these students already before they have developed feelings of belongings. As shown in Paper IV, even students who explicitly aim at doing a doctorate and who consider themselves successful experience a distance to the researcher identity and associated imaginaries of ultimate competence and hegemonic practices in science. The students negotiate being pushed by imaginaries about what it means to do science, science that requires high levels of competence leading to feeling like 'faking it' while learning, revealing that recognised practices and competences are rather far away from what students understand they do along their learning trajectories. Yet, it is not only how they understand themselves, but also how they are recognised by others, such as teachers, which leads to them feeling distant from recognised practices.

Paper I shows that students do not come to university as blank slates; they already have cultural understandings of what it means to do biology. Although it remains to be explored how these imaginaries came about, they show that students draw on science-centred and straight narratives as well as explorative, interdisciplinary narratives. Straight biology path students consider themselves knowledgeable, understand themselves as always having been a science person, and recognise themselves as the right kind of person to study biology. Although inquiries into how these students are met in the actual classroom are still needed, research science teachers' understandings of students as blank slates with low competence and interest risk creating a distance even for students who recognise themselves as close to the practice. Consequently, ideas about science as elite, requiring rather extraordinary competence, interest, and enthusiasm, create distance for both students and teachers. As suggested in Paper II, research science teachers appear to relate so strongly to the imaginary of the researcher as the ultimate knower that it seems impossible for them to position themselves as learners, learning to teach, as it is researchers, so they believe, who hold ultimate knowledge and competence.

Creating narrow spaces for intelligible participation in science is the second problem created if research scientists are positioned at the centre of the educational practice according to Brickhouse et al. (2000). Research as narrow spaces of intelligible ways of doing and being are present in all papers and

even include narrow ideas about intelligible emotions as shown in Paper III. Carlone and Johnson (2007) highlight that defining science identity along a historical and cultural 'prototype, may reproduce status quo and overly narrow conceptions of what counts as a science person' (1212). This status quo, the scientist as a researcher with a narrow interest, is visible in students' and teachers' imaginaries. Science acts as a straightening device, similar to how Sara Ahmed (2016) describes institutions to be straightening devices that diversity workers try to challenge. Backpacking biology path students and facilitating science teachers, while aware of the norms, come up against the very norms. They, to borrow Avraamidou and Schwartz's (2021) words, 'challenge deficit and exclusionary understandings of what science is and who can do science' (343). However, understanding oneself as *other*, as deviating from what is considered the norm, also bears the risk of feeling and being othered, not feeling like one belongs. In the context of higher education institutions, Ahmed (2016) foregrounds this idea: 'When you deviate from a straight line, it is the deviation that needs to be explained' (121), leaving a path that is as well-trodden as the straight and science path sometimes 'mean[s] leaving a support system' (46) and translated to this context, it can mean leaving a space in which one is recognized and hence supported in one's identity work.

It is in the meeting between students and teachers that identities are made possible or impossible and it is in these meetings I can see the potential for change towards more inclusive learning, providing a support system for all students who choose to study biology. bell hooks (1994) reminds us that everyone in the classroom has the responsibility to shape learning; classroom practices, actions, and interactions shape learning collectively. Yet, it is the teachers who hold accountability for and have the institutional power to maintain the status quo or to challenge taken-for-granted norms, what and who they recognise is a political act that makes them, makes us, accountable. In this work, it becomes clear that science identity is not a singular category, not an identity standing for itself, but as Avraamidou highlights 'its meaning derives from a complex, polycontextual, emotional, and intersectional self' (2019: 342) and depends on many factors embedded in identity political spaces of recognition; recognition as part of the support system.

Whose science? Whose knowledge?

This thesis, as well as students that have been part of shaping this project, want biology practices that do not exclude people on the premise of scientific research focus and elitism but rather spaces of scientific subjectivities that encourage inclusion. Asking for a biology that, as one student highlighted, "becomes better at seeing the human beings behind it", behind its practices, behind its research, and behind the science.

Judith Butler highlights that while repetitions are unavoidable, they also become tool to challenge to challenge what is repeated. Butler foregrounds:

> The task is not whether to repeat, but how to repeat or, indeed, to repeat and, through a radical proliferation of gender, to displace the very gender norms that enable the repetition itself. (2007 [1990]: 203)

Backpacking biology path students and facilitating science teachers negotiate their identities in terms of not being, improvising alternatives to hegemonic practices (Holland et al. 1998). These improvisations can function as catalysts of change (Rush and Fecho 2008) and contribute to transgressing circularities, intergenerational reproductions of exclusive norms of doing science, making another science possible[7].

The landscapes of higher education science and higher education biology and the very worlds in which they are embedded are always changing and requite perspectives that account for the complexities of the lived experiences of the people within. This work focuses on the intersections of historically-, culturally-, and socially-constructed practices as well as the participants who navigate these practices along the axis of gender. It reveals the need for critical and intersectional approaches in and to higher education biology and science to broaden our views on and spaces for legitimate participation in science education for all and not just a few, to borrow Anita Hussénius' words (2014). As Donna Haraway stresses:

> It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories. (2016: 12)

It matters what stories we tell. What worlds we make possible. What identities we recognise. What stories could we make possible if we told stories about our winding paths?

6.3 Negotiating lines as an insider and outsider

Directionality has over the course of analyses and writing processes become a concept that helped me understand and explain how the students are directed towards and away from biology and science, directed along straight lines or deviating from them in worlds of higher education biology. Ahmed reminds us that 'life is not always linear' (2016: 46), which made me reflect on the very methodology used when interviewing students, especially the timeline interviews. The line on the paper was meant to provide guidance for the students during interviews. Yet already during the interviews, negotiations along the line became a challenge for many of the students and for me. We went

[7] As Isabelle Stengers (2018) suggests, 'Instituting a plurality of sciences against the unity of "Science" means treating this unity as an amalgam that has to be dissolved in order to free the different ingredients in their particularity.' (59).

back and forth, up and down on these lines, added, moved, replaced points to, on, and from the line: 'To sustain a direction is to support a direction' (Ahmed 2016: 46). In hindsight I can see how that line posed extra challenges to the students, especially those who do not understand their trajectories as straight, as linear; I am grateful for the work they did in negotiating the lines and leaving the lines, helping me to challenge my thinking and to write this kappa. Yet, thinking in lines says also much about my own socialisation and enculturation.

Transgressing, a movement that goes against and beyond boundaries (hooks 2014), can make one an insider and an outsider at the same time. Transgressing physical and paradigmatic disciplinary boundaries made me go beyond the boundaries of my own higher biology education and at the same time made me go against boundaries of higher education. Transitioning from biology towards gender studies and science education made me see things from insides and outsides and from sites in between; it made me explore practices that I have been a part of myself. Transgressions also allowed me to position myself in different, fluid ways.

Insideness in biology gave me access to materiality, to the spaces where I conduct my research (Robson and McCartan 2016), such as the mailing lists and ultimately the empirical material used in this study. Insideness made it possible for me to understand the biology content, centralities of concepts like habitat and niche that students and teachers referred to in their texts, and a tacit understanding of what it means to do biology. Insideness also made it possible for me create familiarity when being in biology spaces and especially when interviewing students. I am an insider and can talk to students about the smell and taste of cafeteria food, about welcoming weeks, quirks of staffs, courses that require certain preparations, and practices that I had experienced as a student. I had insights that created familiarity for the spaces and between participants and me as an interviewer such as a university that I visited before interviewing the students. I had conversations with staff, participated in lectures, joined pub evenings and dinners, and held seminars. I familiarised myself with the university, sat down in front of its coffee shop and bakery in the morning rush hour, took the bus and tram to the university, and walked across the campus. I had gained insight through meeting people, a practice that created familiarity. Familiarity and relatability were also established through shared commonalities such as being the same age, having been to and lived in the same countries, and not being heterosexual. Insideness also helped me negotiate power relations between the participants and me as an interviewer (e.g. Boucher 2017; Glas 2021), positioning myself as a biologist. However, I did not want to assume a general commonality of experience in order to avoid not recognising differences of their and my experiences (LaSala 2003).

Outsideness from the practices of higher education biology made it possible to make things that have been familiar to me, strange (Allan 2018;

Delamont et al. 2010; Mannay 2010). An outsideness to the practice also provided me with theoretical and methodological tools from feminist critiques of science and feminist science education in order to develop a sensitivity for processes inside practices that I have been a part of. However, and as shown in the vignette above, outsideness portrayed me as less competent in certain kinds of spaces, often dependent on what competences and performances were recognised and how I positioned myself in relation to what was recognised.

This, however, also shows that while insideness and outsideness can create insider and outsider dilemmas (Merriam et al. 2001; Mullings 1999), being an insider and being an outsider are also connected to the very context. Mullings argues that while insider/outsider debates often draw on the terms in binary and exclusive ways, being 'fixed attributes', the positionalities are rather dynamic and change 'in time and through space' (1999: 340). My positionalities in the process of conducting this work have been dynamic.

We all negotiate insideness and outsideness, especially when entering new communities. We take with us our previous experiences, make new ones which become more familiar over time. This thesis deals with negotiations of insideness and outsideness and prompts us to ask several questions: What do we take for granted? What have we been enculturated into? What do we reproduce? What do we produce? And for whom?

7 Contributions and implications

A backpack on a table

> We are hosting a seminar. A guest researcher presenting his work. The room starts filling up. One senior female researcher with a background in a natural science now working in higher science education comes in, greets everyone in the room in her friendly manner and puts her backpack on a table with two empty chairs standing in a row with another table at which a male colleague, researcher in biology, is sitting. She walks to the back of the room to take off her winter outdoor pants. When she gets back to the table, both formerly empty chairs next to where her backpack is have filled with two male biology researchers and teachers. When she walks up to the person sitting right next to her backpack, all three men in the row seem in deep conversation, seem to not see her walking up to the table. She waits a few seconds that to me felt like minutes as while I was watching this situation. An unbelievable tension just fills my whole body. Because I know exactly that situation. I have been there myself. After these seconds, the men still ignore her even though she is in their sight. She takes her backpack and walks to a table on the opposite side of the aisle. A part of me admires her for not making it a fuss, not calling them out, not being a killjoy. Another part of me wants to speak up. Wants her to speak up. In the end, I do nothing. This nothingness fills me until today. Not doing anything. Not saying anything. Not feeling like it would make a difference but rather a fuzz. Not wanting to be the killjoy. No, not daring to be a killjoy. Today, it makes me angry and it makes me think. The female researcher is a role model to me, especially in the context of her disciplinary competence. But what does it do to me to see my role models, people that I consider knowledgeable, competent, more than good-enough, to be treated this way? A consequence appears to me now, with some distance and feminist anger: we do not only need role models, we also need to change the ways in which our role models are treated.

This thesis challenges imaginaries of higher education biology as a gender-neutral practice to explore what ways of being (i.e. identities) are considered intelligible in figured worlds of higher education biology. I describe how both normative and alternative identities in worlds of higher education biology are

imagined and how boundaries of cultural and disciplinary practice are reproduced, challenged, and pushed. I explore the possibilities for changing educational cultures and therefore show ways to make higher education biology a more equitable and just space for learning.

In Papers I and II, I show how students and teachers in higher education biology position hegemonic research-focused science identities at the centre of the practice. Although some students and teachers negotiated their identity work in line with these possible identities, others explicitly narrated themselves as not being that kind of person, challenging dominant norms of research as the ultimate practice when doing biology and science. In Paper III, I compare how students and teachers understand and direct enthusiasm, passion, and interest, emotions that occur in implicit and explicit ways in their texts. I found that these emotions, which were not inherently positive and more than a collective meaning, carried meanings and orientations that collided with and among students' and teachers' imaginaries. In Paper IV, I challenge ideas about students who consider themselves successful as agreeing with norms of doing biology and norms of doing science. I show that while having learned to navigate hegemonic norms of doing biology and science in worlds of higher education biology, these students are critical towards them and *comply* with rather than *agree* with the very norms of higher education biology. It is in these disagreements and improvisations from dominant imaginaries of being and doing in higher education biology where there is potential for change, where boundaries are pushed.

7.1 Empirical contributions to feminist science education research

One of the primary goals of my thesis is to challenge ideas about biology as a gender-neutral and a gender-inclusive practice. As opposed to male-dominated natural science disciplines (e.g. physics), research explicitly exploring sociocultural aspects of higher biology education has been rather scarce. By further introducing a sociocultural perspectives, combining the lenses of figured worlds and science identity, I have challenged the gender neutrality myth, mapped tensions in worlds of higher education biology, as well as built on previous findings of identity work in higher education biology. Ultimately, I reconnect feminist science critique and identify imaginaries about science and the scientific practice to direct higher education biology participants' identity work, a straightening of university science practices, leaving those who deviate from the straightness of science with the need to negotiate otherness. Although negotiations of otherness can lead to alienations from practices, these negotiations also challenge the hegemonic practices themselves. Hence, by

exploring both students' and teachers' identity work in worlds of higher education biology, I mapped imaginaries of ways of being that are considered the norm that is related to imaginaries of ways of being that challenge these norms and suggest possibilities for change.

When exploring biology students' identity work, I show that students imagine different paths into and through their higher biology education. Straight paths are built on ideas about early proneness and natural talent to do science with the central aspiration to do research in the future. These paths are considered the norm that students negotiate their identities in relation to—as in line with or different from. Dominant imaginaries of straight paths are challenged by students who explicitly understand themselves as not having a straight path. Furthermore, this study identifies a tendency of male students to draw on dominant imaginaries, while female students tend to draw on alternative ways of being in the world, indicating a socialisation towards dominant and alternative identities along axes of gender. Although negotiating the self in opposition to and deviant from the norms of the higher education biology community risks losing those students as they are hindered from developing a sense of belonging, it also shows how students challenge dominant imaginaries and therefore push the boundaries of legitimate ways of being in higher education biology practices.

Paper I demonstrates the following:

- Upon entering undergraduate biology education, students have already started negotiating and showing an awareness of dominant imaginaries of ways of doing and being in biology that are associated with historically masculine norms of doing science such as raw talent and a narrowness of interest, the privileging of mind over body, and equating higher biology education with aspirations towards research.

- Students negotiate identities along dominant and alternative imaginaries of ways of being in gendered worlds of higher education biology. Female or male students, however, do not exclusively draw on dominant respectively alternative imaginaries.

- Alternatives to dominant imaginaries of ways of being in worlds of higher education biology challenge monolithic ideas about disciplinarity, epistemology, and the research centeredness of higher science education.

When meeting students in higher education classrooms, it is important to understand their motivations and goals, and it becomes imperative to pay attention to how they make sense of the practice that they enter and how they relate themselves to these imaginaries. These findings prompt questions about what

kind of environments, practices, and people students encounter during their higher biology education as well as how they negotiate their identities in relation to these environments, practices, and people throughout their studies. Biology is a rather broad discipline, a breadth that some students even consider a resource. Although this work does not focus on sub-disciplinary practices, numerical gender biases are not only visible along the axis of academic degrees but also across subdisciplines (SCB 2021a). The findings also suggest further research is needed that explores students' identity work before entering university, how imaginaries of biology and science are shaped through enculturation in-school and out-of-school activities, what representations students experience in formal and informal contexts, and how enculturation and representations are entangled with intersecting dimensions of power.

When exploring university biology teachers' identity work, I show that they relate to research as the central practice in worlds of higher education biology. Research science teachers reproduce the centrality of research by merging researcher and teacher identities, teaching as researchers, with the central goal to recruit students into research. Researchers are imagined as ultimate knowers, which I suggest keeps them from positioning students as knowledgeable and themselves as learners. The centrality of research is challenged by university teachers who disconnect researcher from teacher roles. Facilitating science teachers challenge the centrality of research and promote the understanding that teaching is an acquired competence rather than teachers becoming competent through their research competence. By not positioning themselves as ultimate knowers and understanding teaching as a competence to be learned, these teachers could position students as knowledgeable and themselves as learners.

Paper II demonstrates the following:

- University biology teachers negotiate their identities in line with or as deviant from dominant imaginaries of science and the centrality of research. This is also negotiated along ideas of narrow disciplinarity and interdisciplinarity.

- Negotiations of university teacher and researcher identities intersect with negotiations of gender, displaying tendencies of female teachers to challenge the centrality of research and the hegemonic position of the researcher.

It was also visible that

- Teachers' recognition of competences and performances for themselves as well as for their students is heterogeneous. What they recognized in others was influenced by teachers' own experiences of recognition.

- Research-based teaching has been (mis)understood as doing research in class rather than grounded teaching in science education research.

University teachers negotiate their teacher identities in relation to their researcher identities, in line with or different from each other, which also informs how they understand students' identities. This gains particular importance in the context of teacher training courses. On the one hand, it suggests the need to problematise taken-for-granted ideas of what research means and what research informs. On the other hand, it suggests a need to explicitly discuss identities as teachers and researchers for themselves and in relation to students' identity work and aspirations. Although the findings have direct implications for teacher training, they also suggest the importance of further work in dialectical intersections of institutional identities such as researcher, teacher, and student along axes of power such as gender as well as beyond.

A need for studies that take into account both students' and teachers' perspectives and their relationalities becomes visible when comparing how students and teachers make meaning of and direct enthusiasm, passion, and interest in Paper III. This study challenges the assumption that these emotions are collectively understood and inherently positive. I found diverse ways in which students and teachers made meaning of and directed these emotions and found shared and diverging meanings and directionalities among the four identity categories described in Paper I and Paper II. I discuss how these emotions as cultural productions of science are both directed and become directional and suggest that recognizing broader meanings of emotions has the potential to broaden participation in higher education biology and to support students in developing a sense of belonging within.

Paper III demonstrates the following:

- Emotions like enthusiasm, passion, and interest are associated with participation in higher education biology by both university students and teachers; however, students and teachers make meaning in diverse ways and direct these emotions differently.

- Rather narrow understandings of emotions associated with research are opposed by broader meanings of enthusiasm, passion, and interest, widening spaces for recognition and students' development of a sense of belonging to higher education biology practices.

The final paper included in this thesis focuses on how successful biology students who aim to pursue a PhD degree describe and negotiate "typical" ways of doing and being in higher education biology. Across European contexts, I found three shared imaginaries, namely *showing dedication through sacrifice*, *being forced to fake it to make it*, and *surviving of/as the fittest* which are based

on imaginaries of science as requiring high levels of commitment, competence, as well as competitiveness. However, students also criticize and challenge these imaginaries and understand themselves as having been successful *despite* negotiating them.

Paper IV demonstrates the following:

- Imaginaries of biology practice are strongly intertwined with imaginaries about science as requiring high levels of commitment, competence, and competitiveness.

- Higher education biology students who consider themselves successful and want to pursue a PhD negotiate these imaginaries successfully, yet are critical towards and challenge these imaginaries.

Taking the findings of the four papers together, this thesis demonstrates the following:

- Biology is not a gender-neutral higher education science discipline and students and teachers negotiate their identities in relation to gendered norms of scientific practice, especially on a symbolic level.

- Furthermore, I show the existence of implicit and explicit norms in higher education biology, which are grounded in masculine norms of natural science. These norms and values influence even higher education biology practices, a discipline that is both numerically female biased at undergraduate level and among the natural science disciplines rather feminine coded—i.e. a "soft" natural science. Negotiating these norms and negotiating the self as in line with or as deviating from the norms influences the development of feelings of belonging and consequently negotiations of staying in or leaving practices. Disclosing implicit norms in higher education biology makes it possible to problematise them.

- The central position of research in biology educational practices with associated imaginaries about the researcher to hold ultimate knowledge creates narrow spaces for learning for both teachers and students.

- Some students and teachers challenge hegemonic norms of research as the centre of the practice, pushing boundaries towards interdisciplinary higher biology education, towards reciprocal learning interactions between students and teachers, and towards aspirations beyond *Science*.

- Challenging dominant imaginaries can lead to change and a more inclusive high biology education, which also invites those who have not been enculturated into or aspire to participate in a research-centred scientific practice. Developing a more inclusive education provides opportunities to apply and combine knowledge in new ways and therefore develop and broaden biology as a discipline.

7.2 Theoretical and methodological contributions to feminist science education research

In addition to the empirical contributions to the field of feminist science education research, I have further developed theoretical and methodological approaches to interdisciplinary research in gender studies on higher education science.

- I further introduce qualitative research on science identities to higher education biology contexts and bring together students' as well as teachers' perspectives to explore potential intergenerational reproductions of norms in higher education biology and science.

- I build a theoretical framework to explore higher education biology, combining social constructivist and cultural and feminist science critical perspectives to acknowledge the complexity of social worlds.

- I operationalise the framework through discourse analytical analyses on a diverse body of empirical material, demonstrating the value of complex multidimensional analytical encounters.

- I interweave my thesis with autoethnographical descriptions of my accounts with the world to share what informs my work beyond biographical listings, descriptions of the power dimensions that I negotiate, as well as the historical, cultural, epistemological, theoretical, and physical research environments.

- I show that it is important to look beyond supposedly gender-neutral and feminine-coded processes, phenomena, and disciplines. A gender-neutral discourse about the practice does not mean that the practice actually is gender-neutral. That is, oppressive mechanisms need to be understood not only in male-dominated natural science disciplines such as physics and engineering but also in disciplines considered gender-neutral or even feminine.

8 Concluding remarks

Professional training?

In the beginning of my PhD and together with two PhD colleagues, I attended the introductory course for all PhD students starting in the humanities. During one of the first seminars, we talked about the value of a doctoral degree in the Arts and Humanities, focusing on "professional skills and expertise, especially 'humanistic skills' and 'humanistic expertise'" with an invited speaker that holds a PhD degree in history, worked outside of academia for several years, and after his return became associate professor working with engineering education policy and management. Now he is a full professor. Connected to the topic and considering his background, I decided to ask him about his perspective on interdisciplinarity, as I from day one have been struggling with being amongst not only disciplines on one branch of knowledge production, but trying to simultaneously sit on three epistemological branches. Biology and natural sciences, gender studies and humanities, as well as education and social sciences.

So I said.

It was hard.

And I asked.

How can I navigate being amidst of these different disciplines?

His answer was.

If you don't like it, you should leave academia.

I was speechless then. And had no idea that the work, which I was about to do in the years to come would help me work through his answer.

Students entering higher education biology already relate to imaginaries of straight academic paths. Some narrate their stories along these paths, while others highlight theirs as not being straight but winding and diverse as described in Paper I. Also university teachers in Paper II narrate stories in line with straightnesses of research trajectories, narrownesses of interests, and unconditionalities of competences. Yet university teachers also challenge these hegemonic imaginaries and the dominance of research, highlighting the importance of cross-contextual knowledge productions, creative and explorative

thinkings, as well as interconnections of learning and teaching, not as contradictory to scientific knowledge productions, but as central to them. Drawing on bell hooks, I discuss how facilitating science teachers make space for their own and others' learning, allow themselves and others to grow and thereby crate spaces for alternatives to hegemonic exclusionary apprentice-master narratives through being vulnerable themselves and allowing others to be vulnerable, too. Paper IV continues to challenge essentialist and deficit imaginaries of biology, science, and research to be for some with an innate proneness and not for others, concluding that successfully navigating norms of doing science does not mean that students agree with and haven't struggled navigating these very norms. In Paper III, comparisons of students' and teachers' perspectives adumbrate the complexities of intergenerational reproductions of scientific norms and challenge us to rethink our *response*-abilities and our *account*-abilities as students, teachers, and researchers. What science and what other science do we make possible through our narratives?

It is here that I want to reconnect with my speechless self, asking several questions. What if that person himself is navigating norms of academic knowledge productions? What if he experiences tensions of on the one hand representing winding paths while on the other struggling for legitimacy through positioning himself as central to the practice? What if we could have open conversations and embrace diverse perspectives, diverse ways of being and doing in worlds, complexities, instead for painting black and white pictures of either complying with the rules or quitting? It was here, I felt pushed to set a full stop instead for a semicolon. Not only taking a break, but ending the sentence. What if we could overcome pushing people so they end their studies? What if we could allow ourselves and each other to be human beings instead? What if we could tell different stories?

As Donna Haraway said and wrote, it matters what stories tell stories. Telling our stories, how we have been filling our backpacks along winding paths in academic landscapes, using our power to tell stories differently, becomes an act of connection, connecting the living, the bios, to the thinking, the logos. It holds the power to empower and change.

Sammanfattning på svenska

I den här avhandlingen undersöker jag normer och värderingar i den högre biologiutbildningen genom att analysera hur studenter och lärare föreställer sig biologins värld. Jag är särskilt intresserad av hur dessa normer, tillsammans med historiska, kulturella och socialt konstruerade uppfattningar om omvärlden, formar studenternas och lärarnas identitetsarbete. Hur blir man biolog? Vad innebär det att vara biolog? Vilka normer behöver vi navigera i biologiutbildningens värld?

Biologi är ett särskilt spännande vetenskapsområde eftersom de flesta studenter som börjar läsa biologi på kandidatprogrammen är kvinnor. Andelen kvinnliga studenter minskar dock med examensnivån, från i genomsnitt 67 % kvinnliga studenter till ungefär 29 % kvinnliga professorer i Sverige. Även om glastaket eller "leaking pipeline" används som förklaringsmodeller för den låga andelen kvinnor på ledarpositioner inom naturvetenskap, är dessa ofta baserade på faktorer från den privata sektorn, t.ex. familjeplanering, och problemet med att förena familj och karriär. Detta tillvägagångssätt är otillräckligt och bortser från hur sociala normer inom vetenskapliga områden och metoder påverkar både studenter och lärare. Den initialt höga andelen kvinnor bland biologistudenterna och en stereotypisering av biologi som en "mjuk" naturvetenskap har lett till att få studier har gjorts som fokuserar på de sociala normerna inom den biologiska utbildningen på universitetsnivå jämfört med till exempel fysik.

Sociala normer är allmänt accepterade, både underförstådda och uttryckliga regler för samlevnad, t.ex. att man ställer sig i kö när man väntar på sin tur. Normer kan därför ha en reglerande effekt på så sätt att det de kan hjälpa oss att orientera oss i samhället. Normer är dock inte bara reglerande på ett positivt sätt utan kan också vara exkluderande, dvs. de kan ha negativa effekter. Exkluderande normer och normer som till och med är kopplade till konstruktioner av genus blir synliga, t.ex. i vilka discipliner som är stereotypiserade som "typiskt" feminina och vilka som är "typiskt" maskulina. Ett exempel är att fysiken ofta framställs som en maskulin disciplin, en så kallad kultur utan kultur, dvs. en disciplin som är rationell, objektiv och oberoende av sociala och kulturella influenser. Biologi, däremot, är ofta stereotypiserad som en kvinnlig naturvetenskaplig disciplin. Detta gör att biologi och fysik verkar mer inbjudande för vissa än för andra, män respektive kvinnor eller även icke-binära människor. Men hur ser detta ut inom den högre biologiutbildningen?

Vilka normer och uppfattningar finns inom biologin, och hur kan dessa påverka deltagandet och en känsla av tillhörighet i biologin på ett positivt och förstärkande, eller negativt och förminskande sätt?

Ur ett socialkonstruktivistiskt perspektiv är inlärning och lärande inte bara en process där vi samlar in ämneskunskaper, utan det är en process i vilken vi också utvecklas som personer. Lärande innebär att man utgår från ett perifert deltagande och blir mer central i en praxisgemenskap, och att man förstår och förhandlar inte bara ämnets innehåll utan också historiska, sociala och kulturella normer. Dessa förhandlingar är nära relaterade till identitetsarbete; vi förhandlar vilka sorts människor vi är i förhållande till andra, till kunskap, normer och praktiken. Identitetsarbete, alltså hur vi förhandlar våra identiteter i den högre biologiutbildningen, med eller mot historiska, kulturella och sociala normer i dess praktiker, är det jag har utforskat i min doktorsavhandling. Inbäddad i ett eklektiskt ramverk av socialkonstruktivistisk, kulturell och feministisk teori analyserar jag mitt empiriska material med hjälp av diskursanalytiska metoder och ägnar särskild uppmärksamhet åt just vilka normer studenter och lärare i biologi förhandlar om i sitt identitetsarbete.

Den första publikationen, Paper I, undersöker identitetsarbetet hos förstaårsstudenter vid ett svenskt universitet utifrån texter där de reflekterar över sitt studieval och sina mål med studierna. Här kan jag visa att eleverna föreställde sig två vägar in i och genom sina studier: den raka biologivägen (Straight Biology Path) och ryggsäcksbiologins väg (Backpacking Biology Path). Den raka biologivägen beskriver idén att man redan som barn har en dragning till och fallenhet för naturvetenskap, att man redan under skoltiden orienteras mot naturvetenskap och att man börjar studera som en redan kompetent (vetenskaplig) person. Det mål som denna raka utbildningsväg leder till är forskning och vetenskap. Denna väg ofta förhandlas som det ”typiska” vägen, dvs. normen, den "normala" vägen inom biologi och vetenskap. Motsatsen till detta är ryggsäcksbiologins väg. Här ligger fokus inte på en dragning till, utan snarare på ett intresse för biologi och tvärvetenskapliga tillämpningar av biologisk kunskap. Studenterna ser sin utbildning inte som en rak linje utan som en slingrande väg där kunskap bildligt talat samlas i en ryggsäck och sedan används inom eller utanför akademin. Även om de två vägarna inte utesluter varandra, kan jag visa att särskilt kvinnliga studenter föreställer sig den alternativa ryggsäcksvägen, medan manliga studenter tenderar att förhandla om sin identitet längs den raka biologivägen. Centralt här är att den senare förstås som den dominerande vägen, dvs. normen som alla måste förhålla sig till; en idé som bygger på maskulint kodade vetenskapsnormer.

I Paper II, den andra studien i min doktorsavhandling, undersöker jag hur lärare föreställer sig biologiutbildningens värld. Med hjälp av ansökningar till universitetslärartjänster i biologi, och då särskilt de delar där de sökande redogör för sin undervisningsfilosofi, vid ett svenskt universitet, kunde jag beskriva två identiteter som lärare förhandlar om: en forskningscentrerad veten-

skaplig identitet (Research Science Teacher) och en underlättande vetenskaplig identitet (Facilitating Science Teacher). Forskningsinriktade lärare undervisar i egenskap av forskare och placerar forskningen som slutmål för sin egen praktik och därmed också för eleverna. De ser sig själva som förmedlare av kunskap om och entusiasm för forskning och beskriver undervisningen som något som förgyller livet som vetenskapsperson. De ser sin uppgift som att förmedla (god) vetenskap och betraktar vetenskapen som elitistisk. I centrum för denna identitet står den vetenskapliga kompetensen, som framkallas hos studenterna av kompetenta lärare och som förmedlas till studenterna i syfte att rekrytera dem till forskningen, dvs. den praktik som värderas högst. De underlättande lärarna känner till denna dominanta forskningscentrerade identitet, men de motsätter sig den och anser att deras uppgift är att stödja studenterna i att hitta sina egna vägar, oavsett om de befinner sig inom eller utanför den akademiska världen och forskningen. Med utgångspunkt i sina egna erfarenheter strävar de underlättande lärarna efter att ge studenterna tillgång till tvärvetenskapligt lärande och interaktiv undervisning där deras egna intressen formar deras lärande. I motsats till den dominerande uppfattningen att aktiva forskare är de bästa lärarna, gör de underlättande lärarna skillnad mellan vetenskaplig kompetens och kompetensen att undervisa. De menar att hög vetenskaplig kompetens inte är synonymt med undervisningskompetens, utan att båda dessa kompetenser lärs in och förbättras genom träning. I den här artikeln föreslår jag å ena sidan att också tidigare nämnda maskulina vetenskapliga normer är synliga. Å andra sidan föreslår jag att förhandlingen om oinskränkt vetenskaplig kompetens hindrar särskilt forskningsinriktade lärare från att positionera sig som inlärare, vilket också skapar hierarkin: studenter-lärare-forskare.

Särskilt i Paper II blev det tydligt hur känslor som entusiasm, passion och intresse är förknippade med biologisk utbildning och forskning. I Paper III jämför jag därför studenternas och lärarnas perspektiv med fokus på entusiasm, passion och intresse, och framför allt vad dessa känslor är riktade mot. Även om dessa implicit och explicit uppfattas som givna och kollektivt (under)förstådda kan jag visa att entusiasm, passion och intresse inriktat mot forskning dominerar även här, medan entusiasm för undervisning, passion för naturen och ett brett intresse för biologi marginaliseras. Här blir det tydligt att känslor å ena sidan tas för givna i biologiutbildningen och i naturvetenskapen, men å andra sidan riktas de mot olika objekt – inte bara mot forskningen.

Den fjärde och sista artikeln i min doktorsavhandling, Paper IV, är empiriskt förankrad i intervjuer med studenter vid tre europeiska universitet: ett i Sverige, ett i Tyskland och ett i Storbritannien. Med utgångspunkt i alla 27 intervjuer som jag har genomfört, analyserar jag sex intervjuer med studenter som ser sig själva som framgångsrika, och som strävar efter en doktorsexamen, dvs. forskarutbildningen. På så sätt fokuserar mina medförfattare och jag analysen på övergripande normer som eleverna förhandlade fram under sina biologistudier, och hur de förstår sig själva i förhållande till dessa. Vi avslöjar en

kollektiv förståelse för att det anses vara normalt att offra sig, vilket är/som ett tecken på hängivenhet till naturvetenskapen. Studenterna delar en känsla av att tvingas inte riktigt delta i den vetenskapliga praktiken, en känsla av ”fake it until you make it”, eftersom uppfattningen om vilken kompetens som krävs för vetenskapligt arbete skiljer sig mycket från egna eller andras bedömningar och uppfattningar om den egna kompetensen. Studenterna förstår också att det är normalt att man sållar bort studenter i en akademisk miljö som präglas av hög konkurrens. På så sätt blir det synligt att och på vilket sätt studenterna förhandlar om överordnade normer för vetenskap som en prestationsorienterad och elitistisk praktik. Biologi är följaktligen inte undantaget från maskulina naturvetenskapliga normer som påverkar elevernas identitetsarbete. Det som utmärker sig i den här artikeln är att de framgångsrika eleverna motsätter sig dessa normer och betonar att de är framgångsrika trots att normerna fanns och finns. Även framgångsrika studenter som vill gå på forskarutbildning är oense med normerna eller håller med dem endast i begränsad utsträckning. Detta resultat ifrågasätter alltså uppfattningen att framgångsrika studenter är överens om dessa akademiska normer, och visar att ett framgångsrikt deltagande inte betyder att studenterna är eniga med normerna som måste förhandlas och som utgör ett framgångsrikt deltagande. En av intervjupersonerna/informanterna sa att biologin måste bli bättre på att se människan bakom själva praktiken och forskningen.

Sammanfattningsvis har studierna i min doktorsavhandling kunnat visa att biologi inte är en neutral naturvetenskaplig praktik, inte en kultur utan kultur, utan formad av en övergripande föreställning om och övergripande normer inom naturvetenskapen. Naturvetenskapens normer, med forskning som dess centrala praktik, förhandlas av alla deltagare, antingen i samförstånd eller oenighet med dessa normer, längs raka vetenskapliga vägar eller längs slingrande vägar. Sara Ahmed (2016) beskriver dessa raka och ofta besökta stigar som "väl upptrampade stigar" (well-trodden paths), alltså stigar som är ganska lätta att gå på, som gör det lättare att gå, och som också får en att hålla en viss riktning. Hon beskriver också att avvikelsen från dessa vägar ofta måste förklaras, att det kräver ansträngning att gå nya vägar, och att lämna en pålitlig väg kan innebära att lämna ett stödsystem. Att lämna dessa vägar innebär dock också att utmana normer, och steg för steg underlätta för andra att gå på nya vägar – dessa vägar kan skapa förändring.

Jag hoppas att mitt arbete gör det möjligt att trampa upp nya stigar.

Zusammenfassung auf Deutsch

In dieser Doktorarbeit untersuche ich Normen und Werte in der universitären Biologieausbildung und wie sich Studierende und Lehrende die Welt der universitären Biologieausbildung vorstellen. Ich bin dabei besonders daran interessiert, wie diese Vorstellungen von historischen, kulturellen und sozial-konstruierten Normen die Identitätsarbeit derer prägen, die lernend und lehrend an der universitären Biologie teilnehmen. Fragen, die sich mir vor und während dieser Doktorarbeit gestellt haben waren zum Beispiel: Wie wird man Biologin/Biologe? Was bedeutet es, eine Biologin/ein Biologe zu sein? Welche Normen müssen wir in der universitären Biologieausbildung navigieren?

Biologie ist aus der genderwissenschaftlichen Perspektive ein besonders spannendes naturwissenschaftliches Feld, da die meisten Studierenden in Bachelorstudiengängen weiblich sind, der Anteil weiblicher Studierenden allerdings mit dem akademischen Grad abnimmt und in Deutschland von durchschnittlich 65% Studienanfängerinnen auf 27% Professorinnen schrumpft. Während die „Gläserne Decke“ oder die „leaky pipeline“ als Erklärungsmodelle für niedrige Frauenanteile in (natur)wissenschaftlichen Führungspositionen benutzt werden, sind diese oft auf Faktoren des privaten Lebens wie Familienplanung gestützt, als Problem der Vereinbarkeit zwischen Familie und Beruf. Diese Herangehensweise ist unzureichend und vernachlässigt wie sich soziale Normen innerhalb der wissenschaftlichen Sphären und Praktiken auf die Lernenden und Lehrenden auswirken. Der anfänglich hohe Frauenanteil unter den Studierenden und eine Vorstellung über Biologie als „weiche“ Naturwissenschaft haben dazu geführt, dass es im Vergleich zu zum Beispiel universitärer Physikausbildung, nur wenige Studien gibt, die sozialen Normen innerhalb der universitären Biologieausbildung untersuchen.

Sozialen Normen sind allgemein anerkannte, implizite und explizite Regeln des Zusammenlebens, zum Beispiel, dass man sich in einer Schlange hinten und nicht vorne anstellt. Normen können also regulierende Wirkung haben, sie können uns dabei helfen, uns in der Gesellschaft zu orientieren. Normen definieren eine Gruppe aber nicht nur nach innen, sondern sind gleichzeitig auch ausgrenzend, können also negative Effekte haben. Ausgrenzende und geschlechtsspezifische Normen werden zum Beispiel darin sichtbar, dass manche Disziplinen als „typisch“ für Frauen und andere „typisch“ für Männer wahrgenommen werden. Ein Beispiel ist, dass Physik oft als maskuline Disziplin, eine Kultur ohne Kultur, stereotypisiert wird; also als eine Disziplin,

die rational, objektiv und unabhängig von sozialen und kulturellen Einflüssen sei. Biologie als Kontrast wird oft als feminine Disziplin stereotypisiert. Dadurch wirken für manche Studierende Biologie oder Physik einladender als für andere. Doch wie sieht das innerhalb der universitären Biologieausbildung aus? Welche Normen und welche Vorstellungen gibt es in der Biologie und wie haben diese das Potenzial, die Teilnahme positiv oder negativ zu beeinflussen?

Aus einer sozialkonstruktivistischen Perspektive bedeutet zu Lernen nicht nur das Anhäufen von fachlichem Wissen, sondern ist Lernen auch ein Prozess des Werdens. Lernen bedeutet von einer peripheren Teilnahme ausgehend, immer zentraler an einer Gemeinschaft teilzunehmen und dabei nicht nur Inhalt, sondern auch historische, soziale und kulturelle Normen einer Gemeinschaft zu verstehen und selbst handzuhaben. Diese Verhandlungen sind eng verbunden mit Identitätsarbeit: wir arbeiten damit wer wir sind in Relation zum Wissen, den Normen, und Praktiken. Und genau diese Identitätsarbeit, ein Arbeiten entlang von oder entgegen historischer, kultureller und sozialer Normen in der universitären Biologieausbildung, ist was ich in meiner Doktorarbeit untersucht habe. Eingebettet in ein eklektisches Rahmenwerk aus sozialkonstruktivistischer, kultureller und feministischer Theorie, analysiere ich mein empirisches Material in Form von Texten und Interviews mit Hilfe diskursanalytischer Methoden und achte dabei insbesondere darauf, welche Normen Studierende und Lehrende in der Biologie in ihrer Identitätsarbeit verhandeln.

Die erste Publikation, Paper I, untersucht die Identitätsarbeit von Erstsemesterstudierenden an einer schwedischen Universität anhand von Texten, in denen sie über ihre Studienwahl, sowie über ihre Ziele mit dem Studium reflektieren. Ich konnte hier zeigen, dass die Studierenden sich zwei Wege in und durch das Studium vorstellen konnten: den Straight Biology Path (in etwa Geraden Biologie Weg) und den Backpacking Biology Path (in etwa Rucksackwandernden Biologie Weg). Der Straight Biology Path, bezeichnet die Vorstellung, dass man schon als Kind eine Neigung zu den Naturwissenschaften hat, man über die Schulzeit sich schon in Richtung Naturwissenschaften orientiert und dann bereits als naturwissenschaftlich kompetente Person das Studium beginnt. Das Ziel, auf das dieser gerade Ausbildungsweg hinarbeitet, ist Forschung und Wissenschaft. Dieser Weg wird oft als Norm wahrgenommen, der „übliche“ Weg in der Biologie und in der Naturwissenschaft. Dem entgegengesetzt ist der Backpacking Biology Path. Nicht eine angeborene Neigung und Eignung zu, sondern ein Interesse an der Biologie und interdisziplinären Anwendungen von biologischem Wissen stehen hier im Vordergrund. Studierende sehen ihre Ausbildung nicht als gerade Linie, sondern als einen sich schlängelnden Weg, entlang welchem Wissen metaphorisch in einem Rucksack gesammelt und dann innerhalb oder außerhalb des universitären Milieus genutzt wird. Obwohl sich nicht gegenseitig ausschließend,

konnte ich zeigen, dass vor allem weibliche Studierende sich mit einem Backpacking Biology Path identifizieren, während männliche Studierende ihre Identität eher entlang eines Straight Biology Paths orientierten. Zentral hier ist, dass der Straight Biology Path als dominierender Weg, als die Norm verstanden wird, eine Vorstellung, die auf maskulin kodierten Normen der Naturwissenschaft beruht.

In Paper II, der zweiten Studie in meiner Doktorarbeit, untersuche ich wie Lehrende sich die Welt der universitären Biologieausbildung vorstellen. Wenn sich Lehrende für Lehrpositionen in der Biologie an einer schwedischen Universität bewerben, verfassen sie Texte, in denen sie ihre Unterrichtsphilosophie beschreiben. Anhand dieser Texte konnte ich zwei Identitäten beschreiben, die die Lehrenden verhandeln: eine Research Science Teacher Identität (in etwa forschungszentrierte Wissenschaftsidentität) und eine Facilitating Science Teacher Identität (in etwa moderierende Wissenschaftsidentität). Research Science Teacher lehren in ihrer Funktion als Forscher und positionieren Forschung als ultimatives Ziel für ihre eigene Praktik, also auch für die Studierenden. Sie verstehen sich als Überträger von Wissen über und Enthusiasmus für Forschung und bezeichnen die Lehre als die „goldene Umrandung" des Lebens als Person der Wissenschaft, etwas das schmückt, aber nicht den Hauptteil ausmacht. Sie sehen ihre Aufgabe darin, gute Wissenschaft zu vermitteln und positionieren Wissenschaft explizit als elitär. Im Zentrum dieser Identität steht die wissenschaftliche Kompetenz, welche von kompetenten Lehrenden in Studierenden hervorgerufen und an Studierende weitergegeben wird, mit dem Ziel sie in die Forschung als ultimative Praktik zu rekrutieren. Diese Identität ist Facilitating Science Teachern bekannt, sie stellen sich dieser jedoch entgegen und verstehen ihre Aufgabe darin, die Studierenden zu unterstützen ihren eigenen Weg zu finden ob nun inner- oder außerhalb von Wissenschaft und Forschung. Teilweise auf eigenen Erfahrungen beruhend, wollen Facilitating Science Teacher den Studierenden interdisziplinäre Lernmöglichkeiten und interaktive Lernräume zur Verfügung stellen, in denen die eigenen Interessen das Lernen prägen. Im Gegensatz zu einer dominierenden Vorstellung, dass aktive Wissenschaftlerinnen und Wissenschaftler die besten Lehrenden seien, machen Facilitating Science Teacher einen Unterschied zwischen wissenschaftlicher Kompetenz und der Kompetenz zu lehren. Hohe wissenschaftliche Kompetenz sei nicht gleichbedeutend mit Lehrkompetenz und hoher Qualität der Lehre, sondern beide Kompetenzen werden als erlernt und durch Übung verbessert verstanden. In diesem Paper schlage ich zum einen vor, dass maskuline wissenschaftliche Normen auch in der Identitätsarbeit von Lehrenden sichtbar sind. Zum anderen scheint die Notwendigkeit ultimative wissenschaftliche Kompetenz zu verhandeln, vor allem Research Science Teacher davon abzuhalten, sich selbst als Lernende zu positionieren und schafft dabei eine Hierarchie Studierende-Lehrende-Forschende.

Vor allem in Paper II wurde sichtbar, wie zentral Emotionen wie Enthusiasmus, Leidenschaft und Interesse, in Vorstellungen über die universitäre Biologieausbildung und Forschung ist. In Paper III vergleiche ich deshalb die Perspektiven der Studierenden und Lehrenden mit Fokus auf Enthusiasmus, Leidenschaft und Interesse und vor allem, worauf diese gerichtet sind. Während diese Emotionen implizit und explizit als gegeben und kollektiv verstanden werden, konnte ich zeigen, dass auch hier Enthusiasmus, Leidenschaft und Interesse für Forschung dominierend ist, während Enthusiasmus für Lehre, eine Leidenschaft für die Natur und ein breites Interesse marginalisiert werden. Es wird hier sichtbar, dass auf der einen Seite in der universitären Biologieausbildung Emotionen als selbstverständlich angenommen werden, sie jedoch auf der anderen Seite in verschiedene Richtungen gerichtet sind.

Der vierte und letzte Artikel in meiner Doktorarbeit, Paper IV, ist empirisch verankert in Interviews mit Studierenden an drei Europäischen Universitäten, einer Universität in Schweden, einer in Deutschland und einer in Großbritannien. Basierend auf einer Voranalyse aller 27 Interviews, analysiere ich im Detail sechs Interviews von Studierenden, die sich selbst als erfolgreich verstehen und eine Doktorarbeit anstreben, also eine Ausbildung als Wissenschaftlerin und Wissenschaftler. Dabei fokussiere ich die analytische Linse auf übergreifende Normen, die die Studierende während ihres Biologiestudiums kennengelernt haben und wie sie sich diesen gegenüber verstehen. Ich konnte ein kollektives Verständnis beschreiben, dass es als normal angesehen wird, dass Aufopferungen als Zeichen der naturwissenschaftlichen Hingabe gewertet werden. Studierende teilen das Gefühl, gezwungen zu sein, die Teilnahme in der wissenschaftlichen Praxis zu fingieren, ein Gefühl des fake it until you make it, da die Vorstellung darüber welche Kompetenz für wissenschaftliche Arbeit erforderlich ist, stark von der Einschätzung und externen Wahrnehmung der eigenen Kompetenz abweicht. Auch verstehen die Studierenden das Aussieben von Studierenden in einem wissenschaftlichen Umfeld, geprägt von hoher Konkurrenz, als normal. Es wird dadurch sichtbar, dass und wie die Studierenden mit übergeordneten Normen die Naturwissenschaft umgehen und Wissenschaft als eine leistungsorientierte und elitäre Praxis ansehen.

Der Biologie sind folglich maskulin-konnotierte Normen nicht fremd und diese beeinflussen die Identitätsarbeit der Studierenden. Was in diesem Paper besonders hervortritt ist, dass die erfolgreichen Studierenden sich diesen Normen entgegenstellen und betonen, dass sie erfolgreich sind trotz dieser Normen. Sie können sie folglich erfolgreich anwenden, sind aber nicht oder nur bedingt mit ihnen einverstanden. Dieses Resultat fordert damit die Vorstellung heraus, dass erfolgreiche Studierende diesen wissenschaftlichen Normen bedingungslos zustimmen, erfolgreiche Teilnahme ist nicht gleichzusetzen mit einer Zustimmung darüber, was eine erfolgreiche Teilnahme ausmacht. Eine Person, die ich interviewt habe, fordert explizit: Biologie muss besser werden darin, den Menschen dahinter zu sehen.

Zusammenfassend ist zu sagen, dass die Studien in meiner Doktorarbeit zeigen konnten, dass Biologie keine neutrale Praxis ist, keine Kultur ohne Kultur, sondern geprägt von eine übergreifenden Ideen und Normen der Naturwissenschaft. Diese naturwissenschaftlichen Normen, mit der Forschung als zentraler Praxis, werden von allen Teilnehmern unterschiedlich navigiert, entweder in Übereinstimmung oder Nichtübereinstimmung mit diesen Normen, entlang geradliniger oder sich schlängelnder wissenschaftlicher Wege. Sara Ahmed (2016) beschreibt diese geraden und häufig besuchten Wege als well-trodden-paths („gut ausgetretene Wege"), Wege, auf denen es sich recht gut laufen lässt, die das Laufen leichter machen, die einen dazu bringen, eine gewisse Richtung beizubehalten. Sie beschreibt auch, wie es ist von diesen Wegen abzuschweifen, wie es Mühe kostet neue Wege zu gehen, einen verlässlichen Weg zu verlassen; wie es bedeuten kann ein Unterstützungssystem zu verlassen. Diese Wege zu verlassen, bedeutet aber auch Normen herauszufordern und Schritt für Schritt das Gehen auf diesen neuen Wegen für andere zu erleichtern.

Ich hoffe, dass meine Arbeit das Gehen auf neuen, anderen und weniger exkludierenden Wegen für uns möglich macht.

References

Acker, J. (1990). Hierarchies, jobs, bodies: A theory of gendered organizations. *Gender & Society*, *4*(2), 139–158. https://doi.org/10.1177/089124390004002002

Adriansen, H. K. (2012). Timeline interviews: A tool for conducting life history research. *Qualitative Studies*, *3*(1), 40–55. https://doi.org/10.7146/qs.v3i1.6272

Ah-King, M. (2010). Gender and queer perspectives on Evolutionary Biology. In M. Blomqvist & E. Ensmyr (Eds.), *Never mind the gap!: Gendering Science in Transgressive Encounters* (pp. 143–171). Skrifter från Centrum för genusvetenskap/Crossroads of Knowledge.

Ah-King, M. (2012). *Genusperspektiv på biologi*. Högskoleverket.

Ah-King, M., & Ahnesjö, I. (2013). The "sex role" concept: an overview and evaluation. *Evolutionary Biology*, *40*(4), 461-470. https://doi.org/10.1007/s11692-013-9226-7

Ah-King, M., & Nylin, S. (2010). Sex in an evolutionary perspective: Just another reaction norm. *Evolutionary Biology*, *37*(4), 234-246. https://doi.org/10.1007/s11692-010-9101-8

Ahmed, S. (2004). *Cultural politics of emotion*. Routledge.

Ahmed, S. (2016). *Living a feminist life*. Duke University Press.

Allan, A. (2018). Using the once familiar to make the familiar strange once again: engaging with historical inquiry and autobiography in contemporary ethnographic research. *Qualitative Research*, *18*(5), 538–553. https://doi.org/10.1177/1468794118778604

Andermahr, S., Lovell, T., & Wolkowitz, C. (2000). *A Glossary of Feminist Theory*. Oxford University Press.

Andersson, K. (2011). *Lärare för förändring: att synliggöra och utmana föreställningar om naturvetenskap och genus*. Linköping University Electronic Press.

Andersson, K. (2012). "It's funny that we don't see the similarities when that's what we're aiming for"—Visualizing and challenging teachers' stereotypes of gender and science. *Research in Science Education*, *42*(2), 281–302. https://doi.org/10.1007/s11165-010-9200-7

Andersson, K. (2018). Biologi under lupp. Hierarkier, strategier och skevheter. *Tidskrift för Genusvetenskap*, *39*(4), 54–74.

Archer, L., Dawson, E., DeWitt, J., Godec, S., King, H., Mau, A., et al. (2017). Killing curiosity? An analysis of celebrated identity performances among teachers and students in nine London secondary science classrooms. *Science Education*, *101*(5), 741–764. https://doi.org/10.1002/sce.21291

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11- year- old schoolchildren's constructions of science through the lens of identity. *Science Education*, *94*(4), 617–639. https://doi.org/10.1002/sce.20399

Austin, J. L. (1997 [1962]). *How to Do Things with Words*. Harvard University Press.

Avraamidou, L. (2016). Studying science teacher identity. In L. Avraamidou (Ed.), *Studying science teacher identity: Theoretical perspectives, methodological*

approaches and empirical findings (pp. 1–14). Springer. https://doi.org/10.1007/978-94-6300-528-9_1

Avraamidou, L. (2019). Stories we live, identities we build: how are elementary teachers' science identities shaped by their lived experiences? *Cultural Studies of Science Education*, *14*(1), 33–59. https://doi.org/10.1007/s11422-017-9855-8

Avraamidou, L. (2020a). "I am a young immigrant woman doing physics and on top of that I am Muslim": Identities, intersections, and negotiations. *Journal of Research in Science Teaching*, *57*(3), 311–341. https://doi.org/10.1002/tea.21593

Avraamidou, L. (2020b). Science identity as a landscape of becoming: Rethinking recognition and emotions through an intersectionality lens. *Cultural Studies of Science Education*, *15*(2), 323-345. https://doi.org/10.1007/s11422-019-09954-7

Avraamidou, L., & Schwartz, R. (2021). Who aspires to be a scientist/who is allowed in science? Science identity as a lens to exploring the political dimension of the nature of science. *Cultural Studies of Science Education*, *16*(2), 337-344. https://doi.org/10.1007/s11422-021-10059-3

Barad, K. (1996). Meeting the universe halfway: Realism and social constructivism without contradiction. In L. H. Nelson & J. Nelson (Eds.), *Feminism, science, and the philosophy of science* (pp. 161–194). Springer. https://doi.org/10.1007/978-94-009-1742-2_9

Barad, K. (2007). *Meeting the universe halfway.* Duke University Press.

Barton, A. C. (1997). Liberatory science education: Weaving connections between feminist theory and science education. *Curriculum Inquiry*, *27*(2), 141–163. https://doi.org/10.1080/03626784.1997.11075486

Barton, A. C. (1998). *Feminist science education*. Teachers College Press.

Birke, L. I. (1986). *Women, feminism and biology. The feminist challenge*. Harvester Wheatsheaf.

Boucher, A. (2017). Power in elite interviewing: Lessons from feminist studies for political science. *Women's Studies International Forum*, *62*, 99–106. https://doi.org/10.1016/j.wsif.2017.05.003

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. DOI: 10.1191/1478088706qp063oa

Brickhouse, N. (1994). Bringing in the outsiders: Reshaping the sciences of the future. *Journal of Curriculum Studies*, *26*(4), 401–416. https://doi.org/10.1080/0022027940260404

Brickhouse, N. (2001). Embodying science: A feminist perspective on learning. *Journal of Research in Science Teaching*, *38*(3), 282–295. https://doi.org/10.1002/1098-2736(200103)38:3<282::AID-TEA1006>3.0.CO;2-0

Brickhouse, N., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching,37*(5), 441–458. https://doi.org/10.1002/(SICI)1098-2736(200005)37:5<441::AID-TEA4. >3.0.CO;2-3

Brickhouse, N., & Potter, J. T. (2001). Young women's scientific identity formation in an urban context. *Journal of Research in Science Teaching*, *38*(8), 965–980. https://doi.org/10.1002/tea.1041

Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. *Journal of Research in Science Teaching, 45*(9), 971–1002. https://doi.org/10.1002/tea.20241

Bruun, M., Willoughby, S., & Smith, J. L. (2018). Identifying the stereotypical who, what, and why of physics and biology. *Physical Review Physics Education Research*, *14*(2), 020125. https://doi.org/10.1103/PhysRevPhysEducRes.14.020125

Burr, V. (2003). *Social constructivism*. Routledge.

Butler, J. (2007 [1990]). *Gender trouble and the subversion of identity*. Routledge.

Butler, J. (2011 [1993]). *Bodies that matter: On the discursive limits of sex*. Routledge.

Carlone, H. B. (2003). (Re)producing good science students: Girls' participation in high school physics. *Journal of Women and Minorities in Science and Engineering*, *9*(1). DOI: 10.1615/JWomenMinorScienEng.v9.i1.20

Carlone, H. B. (2004). The cultural production of science in reform- based physics: Girls' access, participation, and resistance. *Journal of Research in Science Teaching*, *41*(4), 392–414. https://doi.org/10.1002/tea.20006

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187–1218. https://doi.org/10.1002/tea.20237

Carlone, H. B., Scott, C. M., & Lowder, C. (2014). Becoming (less) scientific: A longitudinal study of students' identity work from elementary to middle school science. *Journal of Research in Science Teaching*, *51*(7), 836–869. https://doi.org/10.1002/tea.21150

Chen, S., Wei, B., & Zhang, H. (2022). Exploring high school students' disciplinary science identities and their differences. *International Journal of Science and Mathematics Education*, 1-18. https://doi.org/10.1007/s10763-022-10257-7

Connell, R., & Pearse, R. (2015). *Gender: In World Perspective.* (3rd ed.). Polity Press.

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory, and antiracist politics. *University of Chicago Legal Forum 1989*(1), 139–167.

Crenshaw, K. (1991). Mapping the margins: Identity politics, intersectionality, and violence against women. *Stanford Law Review*, *43*(6), 1241–1299.

Danielsson, A. T., Andersson, K., Gullberg, A., Hussénius, A., & Scantlebury, K. (2016). "In biology class we would just sit indoors…": Experiences of insideness and outsideness in the places student teachers' associate with science. *Cultural Studies of Science Education*, *11*(4), 1115–1134. https://doi.org/10.1007/s11422-015-9702-8

David, M. E. (2016). *Feminism, gender and universities: Politics, passion and pedagogies*. Routledge. https://doi.org/10.4324/9781315582177

Davies, C. A. (2012). *Reflexive ethnography: A guide to researching selves and others*. Routledge.

Dawson, E. (2014). "Not designed for us": How science museums and science centers socially exclude low- income, minority ethnic groups. *Science Education*, *98*(6), 981–1008. https://doi.org/10.1002/sce.21133

De Laine, M. (2000). *Fieldwork, participation and practice: Ethics and dilemmas in qualitative research*. Sage.

Delamont, S., Atkinson, P., & Pugsley, L. (2010). The concept smacks of magic: Fighting familiarity today. *Teaching and Teacher Education*, *26*(1), 3–10. https://doi.org/10.1016/j.tate.2009.09.002

Eaton, A. A., Saunders, J. F., Jacobson, R. K., & West, K. (2020). How gender and race stereotypes impact the advancement of scholars in STEM: Professors' biased evaluations of physics and biology post-doctoral candidates. *Sex Roles*, *82*(3), 127-141.

Eddy, S. L., & Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research*, *12*(2), 020106. https://doi.org/10.1103/PhysRevPhysEducRes.12.020106

Eddy, S. L., Brownell, S. E., & Wenderoth, M. P. (2014). Gender gaps in achievement and participation in multiple introductory biology classrooms. *CBE—Life Sciences Education*, *13*(3), 478–492. https://doi.org/10.1187/cbe.13-10-0204

Edwards, R., & Mauthner, M. (2002). Ethics and feminist research: Theory and practice. In M. L. Mauthner, M. Birch, J. Jessop and T. Miller (Eds.), *Ethics in qualitative research* (pp. 14–31). Sage.

Eisenhart, M. A., & Finkel, E. (1998). *Women's science: Learning and succeeding from the margins*. University of Chicago Press.

Erdogan, B. (2016). *Humanitarian intervention and the responsibility to protect: Turkish foreign policy discourse.* Springer.

Espinosa, L. L. (2009). *Pipelines and pathways: Women of color in STEM majors and the experiences that shape their persistence.* University of California, Los Angeles.

Evans, J. (1995). *Feminist theory today: An introduction to second-wave feminism*. Sage.

Fausto-Sterling, A. (1985). *Myths of gender: Biological theories about man and woman*. Basic Books.

Foucault, M. (1972). *The archaeology of knowledge and the discourse on language*. Pantheon Books.

Foucault, M. (1976). *The History of Sexuality Volume 1: An Introduction*. London: Allen Lane.

Foucault, M. (1977). *Discipline and Punish*. (A. Sheridan, Trans.). Pantheon New York.

Foucault, M. (1980). *Power. Knowledge.* (C. Gordon, Ed.). Harvester.

Gee, J. P. (2000). Identity as an analytic lens for research in education. *Review of Research in Education*, *25*(1), 99–125. https://doi.org/10.3102/0091732X025001099

Gee, J. P. (1999). *An introduction to discourse analysis: theory and method*. New York: Routledge.

Gee, J. P. (2014 [2011]). *How to do discourse analysis: A toolkit*. New York: Routledge.

Gilbert, J. (2001). Science and its' other': Looking underneath 'woman' and 'science' for new directions in research on gender and science education. *Gender and Education*, *13*(3), 291-305. https://doi.org/10.1080/09540250120063571

Glas, A. (2021). Positionality, power, and positions of power: Reflexivity in elite interviewing. *PS: Political Science & Politics*, *54*(3), 438-442.. https://doi.org/10.1017/S1049096520002048

Gonsalves, A. (2014). Persistent discourses in physics education: gender neutrality and the gendering of competence. *Cultural Studies of Science Education*, *9*(2), 461-467. https://doi.org/10.1007/s11422-012-9423-1

Gonsalves, A. J., Silfver, E., Danielsson, A., & Berge, M. (2019). "It's not my dream, actually": students' identity work across figured worlds of construction engineering in Sweden. *International Journal of STEM Education*, *6*(1), 1–17. https://doi.org/10.1186/s40594-019-0165-4

Gonsalves, A. J., & Danielsson, A. T. (2020). Introduction: Why Do We Need Identity in Physics Education Research? In A. J. Gonsalves & A. T. Danielsson (Eds.), *Physics Education and Gender* (pp. 1–8). Springer. https://doi.org/10.1007/978-3-030-41933-2_1

Gramsci, A. (1971). *Selections from the Prison Notebooks of Antonio Gramsci*. (Q. Hoare and G.N. Smith, Eds.). International Publishers.
Grunspan, D. Z., Eddy, S. L., Brownell, S. E., Wiggins, B. L., Crowe, A. J., & Goodreau, S. M. (2016). Males under-estimate academic performance of their female peers in undergraduate biology classrooms. *PloS one*, *11*(2), e0148405.
Gullberg, A. (2018). Sexig forskning attraherar. (Re) produktion av heterosexuella normer. *Tidskrift för Genusvetenskap*, *39*(4), 75-95.
Gullberg, A., Andersson, K., Hussénius, A., Danielsson, A., & Scantlebury, K. (2014). Gender Knowledge as an Important but Neglected Aspect of Pedagogy of Science. Paper presented at the *National Association for Research in Science Teaching (NARST) Annual International Conference,* Pittsburgh, USA.
Gunnarsson Payne, J., & Öhlander, M. (2017). *Tillämpad kulturteori*. Studentlitteratur AB.
Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies*, *14*(3), 575–599. https://doi.org/10.2307/3178066
Haraway, D. (2003). *The companion species manifesto: Dogs, people, and significant otherness*. Prickly Paradigm Press.
Haraway, D. (2004). *The Haraway Reader*. Psychology Press.
Haraway, D. (2016). *Staying with the trouble: Making kin in the Chthulucene*. Duke University Press.
Harding, S. (1986). *The science question in feminism*. Cornell University Press.
Harding, S. (1991). *Whose science? Whose knowledge? Thinking from women's lives*. Cornell University Press.
Harding, S. (1993). Rethinking standpoint epistemology: "What is strong objectivity"? In L. Alcoff & E. Potter (Eds.), *Feminist Epistemologies* (pp. 49–82). Routledge.
Harding, S. (2006). *Science and social inequality: Feminist and postcolonial issues*. University of Illinois Press.
Harding, S. (2008). *Sciences from below*. Duke University Press.
Harding, S. (2011). *The postcolonial science and technology studies reader.* Duke University Press.
Harding, S. (2016). *Whose science? Whose knowledge?* Cornell University Press.
Harvey, W. S. (2011). Strategies for conducting elite interviews. *Qualitative Research*, *11*(4), 431-441. https://doi.org/10.1177/1468794111404329
Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students: Exploring the intersection of gender, race, and ethnicity. *Journal of College Science Teaching*, *42*(5), 82–91.
Hemmings, C. (2011). *Why stories matter*. Duke University Press.
Hemmings, C. (2012). Affective solidarity: Feminist reflexivity and political transformation. *Feminist Theory*, *13*(2), 147–161. https://doi.org/10.1177/1464700112442643
Holland, D. C., Lachicotte, W., Skinner, D., & Cain, C. (1998). *Identity and agency in cultural worlds*. Harvard University Press.
Holmegaard, H. T., Madsen, L. M., & Ulriksen, L. (2014). A journey of negotiation and belonging: understanding students' transitions to science and engineering in higher education. *Cultural Studies of Science Education*, *9*(3), 755-786. https://doi.org/10.1007/s11422-013-9542-3
hooks, bell. (1981). *Ain't I a Woman? Black Women and Feminism*. South End Press.
hooks, bell. (2014). *Teaching to transgress*. Routledge.

Hussénius, A. (2014). Science education for all, some or just a few? Feminist and gender perspectives on science education: a special issue. *Cultural Studies of Science Education*, *9*(2), 255-262. https://doi.org/10.1007/s11422-013-9561-0

Hussénius, A., Andersson, K., Danielsson, A., & Gullberg, A. (2014). Ämnesinnehåll och genusmedvetenhet i samspel för en mer inkluderande naturvetenskap. *Högre Utbildning*, *4*(2), 109–125.

Hussénius, A., Andersson, K., Gullberg, A., & Scantlebury, K. (2013). Ignoring half the sky: A feminist critique of science education's knowledge society. In N. Mansour & R. Wegerif (Eds.), *Science Education for Diversity* (pp. 301–315). Springer.

Hussénius, A., Scantlebury, K., Andersson, K., & Gullberg, A. (2016). Interstitial spaces: A model for transgressive processes. In J. Bull, & M. Fahlgren (Eds.), *Illdisciplined Gender. Crossroads of Knowledge* (pp. 11–30). Springer. https://doi.org/10.1007/978-3-319-15272-1_2

Jackson, P. A., & Seiler, G. (2017). Identity work in the college science classroom: The cases of two successful latecomers to science. *Science Education*, *101*(5), 716-740. https://doi.org/10.1002/sce.21290

Johansson, A. (2018). *The formation of successful physics students: Discourse and identity perspectives on university physics*. Acta Universitatis Upsaliensis.

Jørgensen, M. W., & Phillips, L. J. (2002). *Discourse analysis as theory and method*. Sage.

Kahle, J. B., & Meece, J. (1994). Research on gender issues in the classroom. In D. L. Gabel (Ed.), *Handbook of Research in Science Teaching and Learning* (pp. 543-557). New York, NY: Macmillan.

Keller, E. F. (1984). *A feeling for the organism, 10th anniversary edition: the life and work of Barbara McClintock*. Macmillan.

Keller, E. F. (1985). *Reflections on gender and science*. Yale University Press.

Keller, E. F. (1988). Feminist perspectives on science studies. *Thesis Eleven*, *21*(1), 65–81.

Keller, E. F. (2016). Thinking about biology and culture: can the natural and human sciences be integrated? *The Sociological Review*, *64*(1_suppl), 26–41. https://doi.org/10.1111/2059-7932.12011

Kelly, A. (1985). The construction of masculine science. *British Journal of Sociology of Education*, *6*(2), 133–154. https://doi.org/10.1080/0142569850060201

Koobak, R., & Thapar-Björkert, S. (2014). Writing the place from which one speaks. In N. Lykke (Ed.), *Writing Academic Texts Differently* (pp. 61–75). Routledge.

Laclau, E., & Mouffe, C. (1985). *Hegemony & socialist strategy*. Verso.

Lane, L., & Jordansson, B. (2020). How Gender Equal Is Sweden? An Analysis of the Shift in Focus under Neoliberalism. *Social Change*, *50*(1), 28–43. https://doi.org/10.1177/0049085719901067

Landén, A. S., & Olofsdotter, G. (2016). 'What should we do instead?' Gender-equality projects and feminist critique. In L. Martinsson, G. Griffin, & K. G. Nygren (Eds.), *Challenging the myth of gender equality in Sweden*, (pp. 163-186). Policy Press.

LaSala, M. C. (2003). When interviewing "family" maximizing the insider advantage in the qualitative study of lesbians and gay men. *Journal of Gay & Lesbian Social Services*, *15*(1–2), 15–30. https://doi.org/10.1300/J041v15n01_02

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Le, P. T., Doughty, L., Thompson, A. N., & Hartley, L. M. (2019). Investigating undergraduate biology students' science identity production. *CBE—Life Sciences Education*, *18*(4), ar50. https://doi.org/10.1187/cbe.18-10-0204

Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*(6219), 262-265. DOI: 10.1126/science.1261375

Lloyd, G. (1993 [1984]). *The man of reason: 'Male' and 'female' in western philosophy*. Methuen.

Longino, H. E. (1987). Can there be a feminist science? *Hypatia*, *2*(3), 51–64. https://doi.org/10.1111/j.1527-2001.1987.tb01341.x

Longino, H. E. (1994). In search of feminist epistemology. *The monist*, *77*(4), 472–485.

Lykke, N. (2010). *Feminist studies: A guide to intersectional theory, methodology and writing*. Routledge. https://doi.org/10.4324/9780203852774

Malm, R. H., Madsen, L. M., & Lundmark, A. M. (2020). Students' negotiations of belonging in geoscience: experiences of faculty–student interactions when entering university. *Journal of Geography in Higher Education*, *44*(4), 532–549. https://doi.org/10.1080/03098265.2020.1771683

Mannay, D. (2010). Making the familiar strange: Can visual research methods render the familiar setting more perceptible? *Qualitative Research*, *10*(1), 91–111. https://doi.org/10.1177/1468794109348684

Marchbank, J., & Letherby, G. (2014). *Introduction to gender: Social science perspectives*. Routledge. https://doi.org/10.4324/9781315797236

Martinsson, L., Griffin, G., & Nygren, K. G. (Eds.) (2016). *Challenging the myth of gender equality in Sweden*. Policy Press.

Mendick, H., Berge, M., & Danielsson, A. (2017). A critique of the STEM pipeline: Young people's identities in Sweden and science education policy. *British Journal of Educational Studies*, *65*(4), 481–497. https://doi.org/10.1080/00071005.2017.1300232

Mensah, F. M. (2012). Positional identity as a lens for connecting elementary preservice teachers to teaching in urban classrooms. In M. Varelas (Ed.), *Identity construction and science education research* (pp. 103–121). Brill Sense.

Mensah, F. M. (2016). Positional identity as a framework to studying science teacher identity: Looking at the experiences of teachers of color. In L. Avraamidou, (Ed.), *Studying science teacher identity: Theoretical perspectives, methodological approaches and empirical findings* (pp. 49—69). Springer.

Merriam, S. B., Johnson-Bailey, J., Lee, M.-Y., Kee, Y., Ntseane, G., & Muhamad, M. (2001). Power and positionality: Negotiating insider/outsider status within and across cultures. *International Journal of Lifelong Education*, *20*(5), 405–416. DOI: 10.1080/02601370120490

Midkiff, B. (2015). Exploring women faculty's experiences and perceptions in higher education: the effects of feminism? *Gender and Education*, *27*(4), 376–392. https://doi.org/10.1080/09540253.2015.1028902

Mills, S. (2004). *Discourse* (2nd ed.). Routledge.

Mohanty, C. (1988). Under Western eyes: Feminist scholarship and colonial discourses. *Feminist Review*, *30*(1), 61–88. https://doi.org/10.1057/fr.1988.42

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences*, *109*(41), 16474–16479.

Mullings, B. (1999). Insider or outsider, both or neither: some dilemmas of interviewing in a cross-cultural setting. *Geoforum, 30*(4), 337–350. https://doi.org/10.1016/S0016-7185(99)00025-1

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational*

Review, *81*(2), 172–209. https://doi.org/10.17763/haer.81.2.t022245n7x47-52v2
Ottemo, A., Gonsalves, A. J., & Danielsson, A. T. (2021). (Dis) embodied masculinity and the meaning of (non) style in physics and computer engineering education. *Gender and Education*, *33*(8), 1017-1032. https://doi.org/10.1080/09540253.2021.1884197
Robinson, F. (2011). *The ethics of care: A feminist approach to human security*. Temple University Press.
Robson, C., & McCartan, K. (2016). *Real world research: A resource for users of social research methods in applied settings*. Wiley.
Rush, L. S., & Fecho, B. (2008). When figured worlds collide: Improvisation in an inquiry classroom. *Teaching Education*, *19*(2), 123–136. https://doi.org/10.1080/10476210802040781
Saldaña, J. (2015). *The coding manual for qualitative researchers*. Sage.
Salzinger, L. (2004). Revealing the unmarked: Finding masculinity in a global factory. *Ethnography*, *5*(1), 5-27. https://doi.org/10.1177/1466138104041587
Sanders, V. (2004). First wave feminism. In S. Gamble (Ed.), *The Routledge companion to feminism and postfeminism* (pp. 26–35). Routledge.
Sanz, V. (2017). No way out of the binary: A critical history of the scientific production of sex. *Signs: Journal of Women in Culture and Society*, *43*(1), 1–27. https://doi.org/10.1086/692517
Scantlebury, K., & Baker, D. (2007). Gender issues in science education research: Remembering where the difference lies. In S. Abell & N. Lederman (Eds.), *Handbook of Research on Science Education* (Vol. 1, pp. 257–286). Mahwah, New Jersey: Lawrence Erlbaum Associates, Inc., Publishers.
SCB. (2021a). Universitet och högskolor. Studenter och examinerade på grundnivå och avancerad nivå 2019/20. *Statistiska Centralbyrån*. https://www.scb.se/publikation/43396.
SCB. (2021b). Personal vid universitet och högskolor. *Statistiska Centralbyrån*. https://www.scb.se/publikation/43407.
Schiebinger, L. (2000). Has feminism changed science? *Signs: Journal of Women in Culture and Society*, *25*(4), 1171–1175.
Schiebinger, L. L. (1993). *Nature's body: Gender in the making of modern science*. Rutgers University Press.
Schinske, J. N., Perkins, H., Snyder, A., & Wyer, M. (2016). Scientist spotlight homework assignments shift students' stereotypes of scientists and enhance science identity in a diverse introductory science class. *CBE—Life Sciences Education*, *15*(3), ar47. https://doi.org/10.1187/cbe.16-01-0002
Schmitz, S., & Ahmed, S. (2014). Affect/Emotion: Orientation Matters. A Conversation between Sigrid Schmitz and Sara Ahmed. *FZG–Freiburger Zeitschrift für Geschlechter Studien*, *20*(2), 13-14.
Shrewsbury, C. M. (1987). What is feminist pedagogy? *Women's Studies Quarterly*, *15*(3/4), 6–14.
Silfver, E., Gonsalves, A. J., Danielsson, A. T., & Berge, M. (2021). Gender equality as a resource and a dilemma: interpretative repertoires in engineering education in Sweden. *Gender and Education*, 1–17. https://doi.org/10.1080/09540253.2021.1963419
Simons, H., & Usher, R. (2012). *Situated ethics in educational research*. Routledge. https://doi.org/10.4324/9780203354896
St. Pierre, E. A. (2000). Poststructural feminism in education: An overview. *International Journal of Qualitative Studies in Education*, *13*(5), 477–515. https://doi.org/10.1080/09518390050156422

Statistisches Bundesamt. (2021). Studierende in Mathematik, Informatik, Naturwissenschaft und Technik-Fächern. *Statistisches Bundesamt*. https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bildung-Forschung-Kultur/Hochschulen/Tabellen/studierende-mint-faechern.html.

Steegh, A. (2020). Change the game, not the girl: Understanding the role of gender-science stereotypes in science competitions. (Doctoral dissertation, Kiel University). https://macau.uni-kiel.de/receive/macau_mods_00001041

Stengers, I. (2018). *Another science is possible: A manifesto for slow science*. John Wiley & Sons.

Sultana, F. (2007). Reflexivity, positionality and participatory ethics: Negotiating fieldwork dilemmas in international research. *ACME: An international E-journal for Critical Geographies*, *6*(3), 374–385.

Traweek, S. (1988). *Beamtimes and lifetimes: The world of high energy physicists*. Harvard University Press.

Trujillo, G., & Tanner, K. D. (2014). Considering the role of affect in learning: Monitoring students' self-efficacy, sense of belonging, and science identity. *CBE—Life Sciences Education*, *13*(1), 6–15. https://doi.org/10.1187/cbe.13-12-0241

Universities UK. (2019). Higher education in facts and figures 2019. *Universities UK*. https://www.universitiesuk.ac.uk/what-we-do/policy-and-research/publications/higher-education-facts-and-figures-2019.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Harvard University Press.

Wade- Jaimes, K., King, N. S., & Schwartz, R. (2021). "You could like science and not be a science person": Black girls' negotiation of space and identity in science. *Science Education*, *105*(5), 855-879. https://doi.org/10.1002/sce.21664

Walker, R. (2001). Becoming the third wave. *Identity politics in the women's movement*, *3*(13), 78–80.

Weller, S. C., Vickers, B., Bernard, H. R., Blackburn, A. M., Borgatti, S., Gravlee, C. C., & Johnson, J. C. (2018). Open-ended interview questions and saturation. *PloS one*, *13*(6), e0198606. https://doi.org/10.1371/journal.pone.0198606

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Wollstonecraft, M. (2014 [1792]). *A Vindication of the Rights of Woman*. London: Vintage.

Appendices

Appendix A

Instructions study motivation text social science entry

Reflektion över mitt studieval - biovetare

Författa en valfri text där du reflekterar över ditt studieval på högst en A4-sida. Ge en bakgrund till ditt studieval. Reflektera över om dina förväntningar blivit infriade så långt och om dina framtidsplaner ändrats under utbildningens gång. Ser du annorlunda på ditt val av biologi nu när du läst ett år? Reflektera över om du tycker att din studieteknik förbättrats under året som gått. Diskutera också vilka annan kunskap (förutom biologi) och vilka andra färdigheter du skulle kunna tänkas behöva som yrkesverksam biolog.

Texten utgör bakgrund för ditt Studiesamtal (din egen tid hittar du i filen "Studiesamtal_TIDER" på kursens sida i Studenportalen). När du laddar upp texten i Studentportalen sparas den automatiskt i din kommunikationsportfölj för att du ska kunna göra jämförelser mellan förväntningar och resultat senare. Du kommer att återvända till din Studievalsmotivering vid handledarsamtal om din kommunikationsutveckling och vid studievägledning.

Skriv ditt namn överst i texten! Döp filen "FörnamnEfternamn" och ladda upp den i Inlämningen "Studievalstext 30 aug" i Studenportalen.

Dead-line för att ladda upp filen är **onsdag 30 augusti kl 16:00**.

Välkommen med din text och till studiesamtalet!

Appendix B

Instructions study motivation text natural science entry

Motivering av mitt studieval

Författa en valfri text där du motiverar ditt studieval på högst en A4-sida. Ge en bakgrund till ditt studieval samt utveckla dina förhoppningar och framtidsplaner. Varför har du valt att läsa biologi? Och varför just i Uppsala? Diskutera också vilka annan kunskap (förutom biologi) och vilka andra färdigheter du skulle kunna tänkas behöva som yrkesverksam biolog.

Texten utgör bakgrund för ditt Studiesamtal (din egen tid hittar du i filen "Studiesamtal_TIDER" på kursens sida i Studenportalen). När du laddar upp texten i Studentportalen sparas den automatiskt i din kommunikationsportfölj för att du ska kunna göra jämförelser mellan förväntningar och resultat senare. Du kommer att återvända till din Studievalsmotivering vid handledarsamtal om din kommunikationsutveckling och vid studievägledning.

Skriv ditt namn överst i texten! Döp filen "FörnamnEfternamn" och ladda upp den i Inlämningen "Studievalstext 30 aug" i Studenportalen.

Dead-line för att ladda upp filen är **onsdag 30 augusti kl 16:00**.

Välkommen med din text och till studiesamtalet!

Appendix C

Informed consent form for students' study motivation texts (printed version)

Studien ingår i en forskningsstudie som handlar om studenters identitetsutveckling i biologi, och betydelsen av den ämnesdidaktiska utbildningsmiljön. Studien kommer att genomföras med studenter som påbörjat sina studier i kandidatprogrammet i biologi/molekylärbiologi vid Uppsala universitet, åren 2014-2020.

Data kommer att samlas in genom studievalsmotiveringstexter, observationer, enkäter och intervjuer. Insamlade data kommer att analyseras av forskargruppen. Vi kommer att presentera våra slutsatser på vetenskapliga och didaktiska konferenser och i vetenskapliga artiklar. För att garantera anonymitet kommer inga namn att nämnas, eller synas för den som analyserar texten. Deltagande i studien är frivilligt och du kan när som helst under studien välja att hoppa av (genom att maila nedanstående). Undersökningen genomförs i enlighet med fastställda forskningsetiska principer.

Ditt medgivande innebär att vi får tillgång till din studievalsmotivering i studentportalen, tillgång till den reflektion du fyllde i samband med DiaNa-handledarsamtal samt att vi kan komma att kontakta dig för att fråga om du vill delta i enkäter och intervjuer.

Katerina Günter, Ingrid Ahnesjö & Annica Gullberg
Centrum för genusvetenskap & Inst. för Ekologi och genetik, i samarbete med IBG (Inst. för biologisk grundutbildning), Uppsala universitet

Om du vill veta mer så hör gärna av dig till Katerina.Gunter@gender.uu.se eller Ingrid.Ahnesjo@ebc.uu.se

Medgivande till deltagande i denna forskningsstudie

☐ Jag ger mitt medgivande till deltagande i denna forskningsstudie.

Datum: ……...

Namn: ……

Personnummer:……..

E-postadress: ……..

……

Underskrift

Appendix D

Informed consent form for students' study motivation texts (online version)

UPPSALA UNIVERSITET

Kurt

Medgivande till deltagande i en forskningsstudie

Studien ingår i en forskningsstudie som handlar om studenters identitetsutveckling i biologi, och betydelsen av den ämnesdidaktiska utbildningsmiljön. Studien kommer att genomföras med studenter som påbörjat sina studier i kandidatprogrammet i biologi/molekylärbiologi vid Uppsala universitet, åren 2014-2020.Data kommer att samlas in genom studievalsmotiveringstexter, observationer, enkäter och intervjuer. Insamlade data kommer att analyseras av forskargruppen. Vi kommer att presentera våra slutsatser på vetenskapliga och didaktiska konferenser och i vetenskapliga artiklar. För att garantera anonymitet kommer inga namn att nämnas, eller synas för den som analyserar texten. Deltagande i studien är frivilligt och du kan när som helst under studien välja att hoppa av (genom att maila nedanstående). Undersökningen genomförs i enlighet med fastställda forskningsetiska principer.Ditt medgivande innebär att vi får tillgång till din studievalsmotivering i studentportalen, tillgång till den reflektion du fyllde i samband med DiaNa-handledarsamtal samt att vi kan komma att kontakta dig för att fråga om du vill delta i enkäter och intervjuer.Katerina Günter, Ingrid Ahnesjö & Annica Gullberg Centrum för genusvetenskap & Inst. för Ekologi och genetik, i samarbete med IBG (Inst. för biologisk grundutbildning), Uppsala universitetOm du vill veta mer så hör gärna av dig till Katerina.Gunter@gender.uu.se eller Ingrid.Ahnesjo@ebc.uu.se

1. Medgivande till deltagande i denna forskningsstudie *

   ○ Jag ger mitt medgivande till deltagande i denna forskningsstudie.

2. Datum *

3. Namn *

   Förnamn | Efternamn

4. Personnummer *

5. E-postadress *

Appendix E

Interview Guide in English for Paper IV

Theme 1: What had happened before you start studying biology?

- What do you think were the most important events in your life that made you apply for the biology programme?
- Were there important people that played a positive or negative role along the way and in your decision making?
- Were there other important factors?
- What expectations did you have towards your studies when you started in the programme?

Theme 2: What has happened during your studies?

- What has happened since you started studying and were there events that influenced how you got to where you are today?
- Were there important people that influenced you and your studies?
- Where on the timeline would you say do your feel most like a biologist? And why? How do you present yourself for others?
- Did something unexpected happen?
- Were your expectations met?
- If you could meet yourself from when you started studying biology, what would you tell them?

Theme 3: Ideas about the future

- What are your next steps?
- What are you thinking about doing in the future?

Appendix F

Interview Guide in German for Paper IV

Thema 1: Was ist passiert bevor Du angefangen hast Biologie zu studieren?

- Was glaubst Du waren die wichtigsten Ereignisse in deinem Leben, die dazu geführt haben, dass Du Biologie studierst?
- Gab es wichtige Menschen, die eine positive oder negative Rolle gespielt haben entlang des Weges oder wenn Du Entscheidungen getroffen hast?
- Gab es andere wichtige Faktoren?
- Welche Erwartungen an das Studium hattest Du, als Du angefangen hast?

Thema 2: Was ist während Deines Studiums passiert?

- Was ist seit dem Beginn Deines Studiums passiert und gab es Ereignisse, die Dich besonders beeinflusst haben auf dem Weg?
- Gab es wichtige Menschen, die Dich während Deines Studiums beeinflusst haben?
- Wo auf Deiner Zeitlinie fühltest Du Dich am meisten wie eine Biologin/ein Biologe? Weshalb? Wie stellst Du Dich anderen vor?
- Ist etwas Unerwartetes passiert?
- Wurden Deine Erwartungen erfüllt?
- Falls Du Dein ehemaliges selbst vom Anfang Deines Studiums treffen könntest, was würdest Du Dir sagen?

Thema 3: Zukunftsideen

- Was sind Deine nächsten Schritte?
- Was denkst Du in der Zukunft zu machen?

Appendix G

Interview Guide in Swedish for Paper IV from

Del 1: Uppföljning av studievalsmotiveringstexterna
Tema 1: Första tankar

- Vad är dina tankar nu efter att du har läst din text?
- Fanns det något som var oväntat?
- Fanns det något i texten som du minns att du skrev eller något som du inte minns att du skrev?
- Fanns det något som du nu skulle skriva annorlunda idag?

Tema 2: Relatera då till nu

- Vad tycker du har hänt sedan du skrev texten?
- Vad skulle du säga till ditt gamla jag om texten nu när du har kommit så långt i dina studier?

Del 2: Utveckla en tidslinje
Tema 1: Vad hände innan du började dina biologistudier?

- Vad tycker du var de viktigaste händelserna i ditt liv som påverkade dig inför att sökta till biologiprogrammet?
- Fanns det viktiga personer som spelade en positiv eller negativ roll i beslutstagandet?
- Fanns det andra viktiga faktorer?
- Vilka förväntningar på studierna hade du när du började?

Tema 2: Vad hände under dina studier?

- Vad har hänt sedan du påbörjade dina studier och fanns det några händelser som påverkade var du är idag?
- Fanns det viktiga personer i den processen?
- När och var på den här tidslinjen skulle du säga att du kände dig mest som en biolog och varför? Hur presenterar du dig för andra?

Tema 3: Hur möttes dina förväntningar?

- Hände något förväntat eller oförväntat?
- (Om du skulle kunna träffa ditt dåvarande jag, vilka råd skulle du ge den personen?)
- Vad är nästa steget?

Vad tanker du göra I din framtid?

Appendix H

Informed Consent Form in English for Paper IV

UPPSALA UNIVERSITET

CENTRE FOR GENDER RESEARCH

LETTER OF INFORMED CONSENT
INTERVIEW STUDY ON BIOLOGY IDENTITY
KATERINA GÜNTER 2019

This informed consent form is directed at students from [redacted] that participate in individual interviews conducted in the context of Katerina Günter's PhD project on biology identity in higher education.

In this study, biology students from three universities in three European countries are interviewed, discussing experiences that influenced their identity work as students in higher biology education. The interviews will be transcribed and analysed by members of the research group. Results from this study will be presented at seminars, conferences and in scientific articles, as well as in the dissertation itself. Pseudonyms will be used when communicating results outside of the research group to secure confidentiality.

Participation in this study is voluntary and it is possible to ask questions and withdraw from this interview study at any given time by contacting Katerina Günter (for example via mail: katerina.gunter@gender.uu.se).

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant_____

Date and Signature of Participant _____

Appendix I

Informed Consent Form in Swedish for Paper IV

UPPSALA
UNIVERSITET

Medgivande i

Hur blir en biolog? En intervjustudie.

Studien du deltar i ingår i samma forskningsprojekt som studievalsmotiveringsstudien som du har deltagit i. Projektet handlar om studenters identitetsutveckling i biologi och betydelsen av den ämnesdidaktiska utbildningsmiljön, alltså vad det egentligen betyder att studera biologi. Studien kommer att genomföras med studenter som påbörjat sina studier i kandidatprogrammet i biologi/molekylärbiologi [redacted] åren 2014-2020 och som har deltagit i studievalsmotiveringsstudien, den första studien i projektet.

Data kommer att samlas in genom individuella semi-strukturerade intervjuer på zoom och analyseras av forskargruppen som kommer att presentera anonyma slutsatserna på vetenskapliga och didaktiska konferenser och i vetenskapliga artiklar, såväl som i populärvetenskapliga sammanhang. För att garantera din anonymitet kommer inga namn att nämnas eller synas för personer utanför forskargruppen. Undersökningen genomförs i enlighet med fastställda forskningsetiska principer efter etikprövningen har blivit godkänd.

Ditt medgivande innebär att vi får tillgång till din studievalsmotivering i studentportalen för att kunna diskutera texten med dig.

Ditt deltagande i studien är frivilligt och du kan när som helst under studien välja att hoppa av (genom att maila Katerina eller Ingrid). Självklart får du alltid kontakta oss när du har frågor kring studien eller projektet och om du vill bli uppdaterad om studiens framsteg.

Katerina (katerina.gunter@gender.uu.se)

som hälsar tillsammans med Annica Gullberg
och Ingrid Ahnesjö som är med i forskargruppen.

Jag informerades om studiens innehåll, fick tillfälle att ställa frågor och fick dem besvarade. Jag (ditt namn) vill fortfarande delta i studien.

ACTA UNIVERSITATIS UPSALIENSIS
Uppsala Interdisciplinary Gender Studies
Editor: Helena Wahlström Henriksson

1. Nicole Ovesen, *Intimate Partner Violence and Help-Seeking in Lesbian and Queer Relationships*: *Challenging Recognition.* 2021.
2. Juvêncio Manuel Nota, *Women and Biological Research Careers in Higher Education in Mozambique: A Case Study of Two Public Universities*. 2022.
3. Katerina Pia Günter, *Figuring Worlds; Imagining Paths: A Feminist Exploration of Identities in Higher Education Biology*