"It's not my dream, actually": students' identity work across figured worlds of construction engineering in Sweden

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Abstract

Background: Research in engineering education has pointed to the need for new engineers to develop a broader skill-set with an emphasis on "softer" social skills. However, there remains strong tensions in the identity work that engineers must engage in to balance the technical demands of the discipline with the new emphasis on heterogeneous skills (Faulkner, Social Studies of Science 37:331–356, 2007). This study explores how three unconventional students experience these tensions in the final year of their construction engineering program, and as they move in and out of workplace field experiences.

Results: Using a figured worlds framework (Holland et al., Identity and agency in cultural worlds, 1998), we explore the dominant subject positions for students in construction engineering classroom and workplaces in a 3-year Swedish engineering program. Results demonstrate that dominant subject positions for construction engineers can *trouble* students' identity work as they move across classroom and workplace settings.

Conclusions: This study expands our knowledge of the complexity of students' identity work across classroom and workplace settings. The emergence of classroom and workplace masculinities that shape the dominant subject positions available to students are shown to trouble the identity work that students engage in as they move across these learning spaces. We examine students' identity strategies that contribute to their persistence through the field. Finally, we discuss implications for teaching and research in light of students' movements across these educational contexts.

Keywords: Engineering, Masculinities, Identity, Heterogeneity

Introduction

This article focuses on Swedish construction engineering students' narratives of experiences in their engineering education program and associated workplace experiences. In contemporary engineering education, there is an emerging focus on changing engineering cultures to attract new students, and to adequately equip engineering students for workplace settings. This is particularly true in construction engineering, which has been historically almost exclusively male-dominated and associated with hegemonic forms of masculinity (Ness, 2012). Alongside the question of the persistent lack of diversity of students in engineering education, there is also evidence that there is increasing disengagement of

students throughout their degree programs (Ohland, Sheppard, Lichtenstein, Eris, Chachra, & Layton, 2008), which may be related to pedagogical practices and classroom experiences that are misaligned with professional practice (Adams, Evangelou, English, De Figueiredo, Mousoulides, Pawley, & Wilson, 2011). To remedy this, it has been argued that engineering education needs to change to reflect the heterogeneity of skills and forms of work in which engineers actually engage in the workplace (Faulkner, 2007). Faulkner (2000) argues that a technical/social binary is invoked when engineers describe their work and the forms of competence required to be a successful engineer. These technical and social skills are often translated into hierarchies privileging technical practices over social skills and activities. Despite this, Trevelyan (2010) argues that social skills are critical to engineering practice and engineering itself should be reframed as a "human social performance" (p. 187) and that social skills

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and interactions be repositioned as central to engineering research, practice, and education. As a result, team-based working environments are increasingly in-demand in engineering work places (Sahin, 2010), and engineering programs tend to be constructed around team-work projects (e.g., Marra, Steege, Tsai, & Tang, 2016; Tonso, 2006a) and problem-based courses (de Graaff & Kolmos, 2007) to reflect this demand.

Research characterizing programs that prepare engineers for the workplace suggest that meaningful professional experiences like service learning or field placement opportunities can provide students with a view of the importance of learning to 'work with people', and develop 'leadership skills' (e.g., Huff, Zoltowski, & Oakes, 2016). The 'new engineer' with both technical and social competence is described in the literature with increasing importance (e.g., Berge, Silfver, & Danielsson, 2018; Dahlbom & Mathiassen, 1997; Sahin, 2010). These characterizations emphasize the importance of social skills, and the ability to work collaboratively in teams. However, despite this increased demand for a broader skill-set and an increased emphasis on 'softer' social skills, there still remain strong tensions in how engineers engage in identity work in order to reconcile 'authentic' or technical engineer identities with the heterogeneous demands of the collaborative education programs and workplaces (Faulkner, 2007). For example, Lagesen and Sørensen (2009) found that while engineers do not overtly distinguish between 'technical' and 'social' knowledge in their work, analysis revealed that social skills (like communication) were framed as the exercise of technical knowledge in combination with lay skills (commonly associated with women) that most people already have. This framing thus retains the privileged hierarchical positioning of technical competence even in circumstances where social skills are the more desired competence. In Sweden, this emphasis on retaining the technical while building social skills was echoed by companies who indicated that they would welcome the development of social skills, as long as the technological core of curriculum was not compromised (Teknikföretagen, 2012). As researchers strive to understand how engineers navigate the technical and social demands of their discipline, Trevelyan (2010) reminds us that "we can only fully understand engineering if we understand how people think, feel, act, and interact as they perform it" (p. 187). This suggests a look to identity as central to understanding engineering practices, who they include and who they exclude.

There is a growing body of research examining engineering identity from sociocultural perspectives. Research related to professional identity in engineering has documented the salience of internships and group work to identity development (e.g., Eliot, Turns, & Xu, 2008).

These researchers found that explicit opportunities to reflect on their professional practice (i.e., through portfolios) promoted the development of professional identities (Turns, Sattler, Eliot, Kilgore, & Mobrand, 2012). Other studies suggest that students' abilities to see themselves as engineers are impacted by identity productions that intersect with ascribed identities (racial/ethnic affiliations, social class, sexuality or gender) (e.g., Foor, Walden, & Trytten, 2007). Those students may experience obstacles that block their efforts to build engineering identities as members of engineering groups (e.g., difficulties relating to individualistic and competitive nature of curriculum; feelings of isolation as a minority) (Foor et al., 2007; O'Connor et al., 2007). Considerable research has examined the salience of gender in students' experiences in engineering education programs. Much of this research has been focused on increasing the recruitment and retention of women in engineering education programs (e.g., Powell, Dainty, & Bagilhole, 2012). Other studies have focused on the gendering of engineering practices in workplace cultures (Faulkner, 2007, 2009), the gendered experiences of students in engineering education programs (Walker, 2001), and the gendered production of engineering identities in campus figured worlds of engineering (Tonso, 2006b). Huff, Smith, Jesiek, Zoltowski, and Oakes (2018) have pointed to the salience of gender in the interaction between engineers' professional and non-professional identities. These researchers provide us with a picture of how women, when developing identities as early career engineers, feel a sense of distance from their families. This became salient as they envisioned their careers in the future, and the choices they may have to make between staying close with their families or building their careers as engineers.

Women in engineering have been described as "breaking down barriers"—either by crossing the border of a gender-divided field of work, or by challenging male domination in engineering hierarchies by entering into competition for resources (Kvande, 1999). These barriers can create troublesome identity work for those who nevertheless enter a field where they may be regarded as "unconventional" and may not be recognized as "competent" or "belonging." Tonso's (2007) study of campus engineer identities documented the production of normative engineering identities construed around ideals of technicist expertise, masculinities, heterosexuality, middle-class values, and whiteness. But in her study, she found that despite these constraints, engineering students engaged in identity productions that did not align with the campus ideals. Thus, engineering students whose identity affiliations were outside of the campus engineer norms dealt with complex choices about how

they would engage in engineering, what kinds of careers they would pursue, and how they identified as engineers (Tonso, 2014). This is significant to our study, as we will describe how the available identities in construction engineering cultures are also constructed around gendered ideology produced in the engineering education program and workplace, and that positioning around these may be troubled for *both* men and women.

In this study, we profile three construction engineering students who do not "fit" into the dominant cultural forms for engineers that are produced in the contexts of their education program and of engineer workspaces. Thus, we are presented with three unique stories of male and female construction engineering students who engage in troubled identity work across learning sites (classroom and workspace). We identify these three students as *unconventional* because they do not fit neatly into the available cultural forms for construction engineer (e.g., Tonso, 2006b) in either the classroom or the workplace. The data presented here is narrative in nature but is derived from students' experiences of the engineering education program and their experiences on field visits and work placements in engineering workspaces. In this sense, we are able to track how the participants see themselves as construction engineers in relation to these different cultural contexts. While we identify these three participants as unconventional, we emphasize that these three participants did not narrate themselves as unconventional in ways that would position them as outsiders to engineering culture. Rather, we suggest that the trajectories they narrate are unconventional, in that they navigate complicated forms of identity work as they progress in their engineering careers, particularly as they move from the classroom to the workplace. We consider navigation much in the same ways as Stevens, O'Connor, Garrison, Jocuns and Amos (2008) that entails examining how a person "moves through the personal and institutional pathways as an engineer-in-the-making to be officially recognized in one or more ways as 'an engineer', pathways that are cut along both official and unofficial routes" (p. 356). However, building on Stevens et al., we also regard these navigations as identity work, that may yield trajectories (Wenger, 1999). As such, we make a contribution to previous research about engineering identities (e.g., Godwin, Potvin, Hazari, & Lock, 2016; Stevens et al., 2008) by considering how students do identity work when moving from educational to professional contexts. The aim of this paper, then, is to highlight the ways that identity work can be problematic for unconventional students across contexts.

Theoretical framing
Identity work
This paper takes learning to entail the acquisition of concepts but also the construction of identities in the social contexts in which those concepts are acquired. This sociocultural approach suggests that we cannot understand learning without also understanding individuals' interactions with their learning contexts (Engeström, 1987). Learning contexts are shaped by discourses that make up that field and, in turn, discourses shape and are shaped by the identities of actors who engage in activities of the field (Lemke, 2001). Thus, we are interested in how construction engineering students navigate the discourses that populate construction engineering education, and how in doing so, they are learning to become construction engineers. In this sense, we are exploring students' identity work in engineering, which entails authoring oneself as a recognizable engineer (Carlone, Scott, & Lowder, 2014; Gee, 2000–2001). As with identity, we also understand gender as performative (Butler, 1990), and constructed through a "stylized repetition of acts" (p. 140) like behaviors, dress, and speech that are locally understood and accepted. What is regarded as masculine or feminine, and how these are assigned value and attributed to male or female bodies, is specific to the context of a local culture (e.g., an engineering education program or an engineering workplace), and we understand that an individual of any gender may perform a number of masculinities and femininities in various recognizable ways in various local contexts.

Positioning and authoring in figured worlds
To characterize identity work in which participants engage, both in the construction engineering classroom and workplace, we employ the useful heuristic of *figured worlds* or "frames of meaning in which interpretations of human actions are negotiated" (Holland, Lachicotte, Skinner, & Cain, 1998, p. 271). Figured worlds are the "socially and culturally constructed realm [s] of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (Holland et al., 1998, p. 52). These figured worlds provide contexts for identity work and provide resources for actors that guide their behaviors in those worlds. We may think of figured worlds as "guidelines" or "social forces" that influence behaviors in social spaces (Hatt, 2007).

Gee (2010) has provided a helpful toolkit to operationalize figured worlds in discourse analysis, and he argues that figured worlds can be thought of as individuals' taken-for-granted theories about the way things are. This is a helpful tool to identify construction engineering students' stereotypical first impressions and simplified stories about the way the construction engineering world works, and their position in it. These simplified stories have important analytical value for

understanding students' identity work, and the figured worlds of the construction engineering classroom and workplace can also define appropriate content and practices for construction engineering and can give a sense of what is right and possible for actors to do to be recognized as construction engineers in those contexts (Holland et al., 1998). Thus, figured worlds may also include ways of *doing* university or doing engineering (in university or in the workplace). Additionally, identity work in and across figured worlds entails positionality. Carlone et al. (2014) have shown how students may position themselves as an insider, outsider, or peripheral in the context of their figured world of science. These social positions can become dispositions such that "people 'tell' each other who they claim to be" (Holland et al., 1998, p. 138) through the process of *authoring*. Authoring may take place unreflectively, even if it entails the rejection and transformation of identities.

Dominant subject positions

To operationalize the figured worlds theory empirically, Jackson and Seiler (2013) have emphasized that "figured worlds rely on cultural models" (p. 828). Cultural models "consist of schemas (mental/emotional knowledge structures) that guide attention to, draw inferences about, and evaluate experience" (Holland et al., 1998, p. 297). To explore construction engineering students' positionality in education and workplace contexts, we find Carlone et al.'s (2014) framing of "celebrated subject positions" as cultural models of acceptable identities a compelling theoretical tool. This framing permitted the researchers to examine stories about "who counted as a legitimate scientific person and what counted as a celebrated scientific performance" (p. 839). As Carlone and colleagues reported, becoming "scientific" meant being positioned as a "good" participant in the science class or being able to fit in with the classrooms celebrated subject positions for science. They argue that this permits an analysis of the problematic identity work that emerges when actors have difficulties identifying with available celebrated subject positions, which may be racialized, gendered, or classed in ways that are inaccessible to some actors. We adapt this construct to examine *dominant subject positions* in the figured worlds of construction engineering, and we explore how students author themselves in ways that may be understood as "retelling and reinterpretations of events and identity formations" (Jackson & Seiler, 2013, p. 829). We also seek to examine how students' positioning in relation to these dominant subject positions may be regarded as troubled or untroubled (Wetherell, 1998). By denoting these subject positions as "dominant" rather than "celebrated," we highlight that subject positions might hold substantial power within a given figured world, without

necessarily being institutionally endorsed (by, e.g., university teachers). We understand that these accounts of identity work are ongoing and dynamic.

Methodology
Context

This study took place in a 3-year construction engineering program at a large university in Sweden. The program structure entails basic construction and mathematics courses in the first year, and in the second and third year students choose from a variety of discipline-specific building engineering and physics courses. During those courses, students learn to plan and implement construction projects, along with additional courses on industry laws and regulations as well as maintenance planning. The education program concludes with a degree project. The specific course from which we obtained this data is designed around group work and field visits to construction sites. As this is largely a technical program, students graduate with a Bachelor in Engineering and if they wish to continue to a Master's degree in engineering, they would need to do so at a different university.

Participants

The three cases presented here are part of a larger study involving 13 participants from construction engineering and the mechanical engineering program. Engineering classes were visited by the second and fourth authors, and students were asked to participate in a study about how group work is experienced in engineering education programs. Six students from the construction engineering program and seven students from the mechanical engineering program agreed to participate in the study. The three cases presented here were selected because they were in the last year of study, and each had unique experiences in the construction program. None of these three participants described engineering as their first choice, or a natural choice, and none described a strong sense of belonging in the field or the program – descriptions which have been recently discussed as salient to identity work in the field (Danielsson, Gonsalves, Silfver & Berge: The pride and joy of engineering? The identity work of male working-class engineering students, submitted; Rainey, Dancy, Mickelson, Stearns, & Moller, 2018). Taking as a whole the data collected in this study, these three participants stood out because all three struggled through the program in different ways, yet they continued to persist. At the time of this study, all three participants were at the end of their university career (at the end of their third year). Follow up email communication

confirmed that each had persisted into jobs in their chosen field.

Data collection

The data presented in this article comes from a project entitled "Remoulding Engineering: Knowledge and Identity Perspectives on Project work in Engineering Education," which entailed data collection across disciplinary sub-fields in engineering. This paper reports on findings from qualitative data collected from three students in their third year of a 3-year construction engineering program at a Swedish university.[1] The data was collected during 2016–2017 and entailed individual interviews and video diaries.

Video diaries (Noyes, 2004), a novel data collection method used to generate narratives of experience, were collected from all students participating in the study. Participants were asked to record three video diaries (short in length, often around 5 min) on cameras that were loaned to them for the duration of the study. The video diaries were structured so that the participants received instruction on what to talk about and were timed so that the diaries were recorded and collected at the beginning, the middle, and at the end of their group project. In each video, they were asked to reflect on the group project, but additional instructions were also given for each diary as follows (complete questions, translated from Swedish to English, can be found in Additional file 1):

> Video diary 1: Background information, what motivated participants to apply to this engineering program, and what it is like to be a construction engineering student
> Video diary 2: The participants were asked to report on their ongoing project, and the engineering education program more generally (classes, students, etc.)
> Video diary 3: Participants were asked to describe what they aspire to become after the program. They were asked to read through three case stories[2] about "possible engineering identities" and then were asked to respond to the possible jobs and lifestyles described

Following the collection of video diaries, participants were invited to participate in semi-structured interviews (Kvale & Brinkmann, 2009) framed around themes related to group work, identity work, and engineering education broadly. The interviews were conducted by the second and fourth authors. Interviews were individualized as interesting points for discussion were picked up from video diaries and expanded upon. An interview guide (translated from Swedish to English) can be found in Additional file 2.

Analysis

After transcription, the transcripts were validated by the Swedish-speaking members of the research team, reading the transcripts and listening to the corresponding audio and video files. Files were transcribed from Swedish to English, and the whole team re-read each interview, spending time iteratively reviewing each individual transcript, and discussing them as a team. Swedish verbatim transcripts were translated to English but kept in a side-by-side document with the original Swedish for analysis. Thus, the English readings were verified against the Swedish transcripts. It was important in this analysis to preserve Swedish meanings for terms, especially those, for instance the Swedish word "Brunkare" (described in a later section) which did not have clear English equivalents. The first layer of analysis entailed looking broadly for themes across the interviews (Braun & Clarke, 2006). This entailed open-coding (e.g., Saldaña, 2009) of the transcripts (annotating and highlighting sections) and paying attention to how participants' talk positioned themselves and others relative to the engineering program and workplace. This thematic analysis yielded broad themes including "masculinity," "engineering student culture," "engineering education," and "engineering workplace." This more empirically-driven approach to data analysis yielded a strong focus on the three participants featured in this paper. These three participants emerged as focal subjects for the research team when we noticed that their narratives did not fit the dominant patterns emerging around themes related to masculinity and engineering student culture.

The second phase of data analysis engaged all members of the research team. This stage was more theoretically driven, guided by Holland et al.'s (1998) notion of "figured worlds" and "cultural models." Emerging from our thematic analysis were strong themes around engineering student culture and engineering workplace, within which were different descriptions of masculinity and typologies for construction engineers. To help us characterize students' narratives of the engineering program and the workplace setting, and to understand how their narratives constituted episodes of identity work in those settings, we employed Gee's (2010) "figured worlds tool." This tool was applied to interview data for characterizations of appropriate ways of doing engineering and being construction engineers. This entailed looking for episodes in the data where participants discussed appropriate ways of acting, interacting, talking, writing and doing research, communicating and dressing, as well as appropriate beliefs and values (Gee, 2001). Gee (2010) has recommended approaching narrative sections of data with the question: "What typical stories [are] the words and phrases of the communication assuming and inviting listeners to assume? What participants, activities,

ways of interacting, forms of language [etc.] are in these figured worlds?" (p. 171). This approach yielded possible "figured worlds" and "dominant subject positions" that were verified across the three interviews. We identified several instances where dominant subject positions of construction engineering seemed to intersect with participants' authoring of themselves as recognizable engineers. Each of these "dominant subject positions" was verified in research team meetings. During those meetings, participants' narratives were examined on a case-by-case basis to generate profiles of participants, before looking across the set of three transcripts to verify dominant subject positions. We approached the data in such a way to retain the integrity of the participants' complete narrative, and to preserve the idiosyncratic perspectives of each of these participants, who at times challenged the patterns emerging in analysis.

We then examined how these dominant subject positions enabled or constrained participants' identity work and we went back into the data to explore how participants author themselves as recognizable, or how are they positioned by others. Following Carlone et al. (2014), we paid attention to episodes of conflict that highlighted students' struggles and frustrations in ways that might illuminate discrepancies between the students' identity work and the dominant subject positions of the setting. These episodes were then considered to represent either *troubled or untroubled* (e.g., Wetherell, 1998) positions for the participants as they moved through the figured worlds of the construction engineering classroom and workspace. To further qualify how the positioning done by the students in relation to the dominant subject positions is played out, we have found the metaphor of "vectoring" (e.g., Brickhouse, Eisenhart, & Tonso, 2006) useful. The concept of vectoring was developed abductively during the final stage of our analytical process, as it provided a fruitful way to conceptualize the students' navigation in figured worlds. By vectoring, we refer to a movement either toward or away from identification as an insider to construction engineering. This happens through episodes when the participants are positioned or author themselves in troubled/untroubled ways around those dominant subject positions. These episodes of vectoring toward or away from identification helped us to identify short term *identity trajectories*—which could be inbound, outbound, or peripheral (Wenger, 1999)—that shape the students' persistence through their engineering education and into engineering careers.

As there are multiple sources for data in each case study (interviews, video diaries, emails), we have indicated the source code for each piece of data (for this manuscript, INT = interview, VD = video diary) along with cataloging codes. Episodes selected for publication were edited for comprehension. Pauses in the transcript

are indicated by ellipses […]. In instances where the authors have taken the liberty to substitute words or phrases to fit the transcript into the surrounding text, the edit is marked with a square bracket []. All participants have been assigned pseudonyms, and any confidential information has been removed from the dataset.

Results and discussion

The following sections are organized to present the participants, how their talk constructs the figured worlds that intersect with construction engineering, and how they position themselves around the dominant subject positions made available through those figured worlds. We begin with a brief description of each informant, and discuss their background, their goals, and their trajectories into the workplace. We then present examples of the figured worlds that populate the construction engineering education program, and the construction workplaces, as these informants have described them. Through those descriptions, we identify the subject positions that are prominent in the engineering education program and associated workplaces and discuss the forms of positioning in which the participants engage in order to author recognizable identities. This section profiles three unconventional students who negotiate these figured worlds and dominant subject positions, in various ways. We suggest that these identity negotiations are not exclusive to women, and we profile in particular how dominant subject positions trouble the identity work of both men and women students.

The case studies
Layla
Layla's family moved to Sweden from the Middle East 10 years prior to her participation in this study. Her parents chose to come to Sweden so that Layla and her siblings would have access to higher education and job opportunities. Her parents were themselves highly educated and had high expectations for their children, all of whom similarly pursued degrees in science and technology fields. Layla's motivation to study construction engineering comes from a desire to gain a degree in higher education; in a bid for authenticity (Faulkner, 2007), she argues that she has always had a persistent interest in building and construction, with a goal of pursuing a career in architecture.

Layla chose to attend the construction engineering program at Swedish University because she did not wish to move away from her parents, who also lived in a nearby city. For Layla, the convenience of the program and the location of the university were more important than the content of the program and the job prospects. "For me, yes," she affirmed/said. "Yes, I did not want to

move. And that was, I was lucky that there was this education here." (INT L).

At the conclusion of the study, Layla found a job in architectural engineering, the field she had initially envisioned working in. She now works with a firm in the city where her parents live. We recall this that is significant in light of findings by Huff et al. (2018) that engineering trajectories may interfere with the desires of early-career engineers to also stay in close contact with family members. In a follow-up email exchange, she described her daily activities as involving drawing and project planning. She appeared to be satisfied with her job even though she found the work is a bit too demanding. Layla explained that she enjoyed the drawing and did not feel that she would find comparable work anywhere else.

Monica

Monica came to this program later in life than most of the students in her cohort. She had a family (two children) and in her previous professional life, she worked as a ski instructor in a small community in the Alps and also worked in the hotel and restaurant industry. In her late 30's, she met her partner and moved back to Sweden to start a family. Monica seemed acutely aware of her positioning in the group as an older woman with a family. She mentioned several times in interviews that she is "older" and this shapes the dynamics with other students during group work and her interactions with technology in the program. Monica described how she came to construction engineering rather serendipitously—she had been looking to engage in further education and had not considered engineering because she felt that she did not have the "intellectual capacity." However, given her father's career as a carpenter, she felt an affiliation with construction engineering and found that it became most interesting "perhaps because it was best known" to her.

Monica was primarily interested in construction engineering for a job and did not express an interest in further education in this field. However, she did not dismiss the possibility of further education, claiming, "I have done this, now, so why not, there are no whys. You set the boundaries yourself" (INT M). At the moment of completing the program, Monica was primarily keen to find work that "generates better pay" than her previous career and to have a job where "there is a lot of money in the account and I just think I've been at work and had fun" (INT M). Coming from a working-class background, Monica emphasized that "I think that it has been a driving force that I will not have to 'turn the coins' once the month is over" (INT M). Beyond money, Monica was also driven by a desire to "become something," and construction engineering seemed like the way to finally achieve a professional identity.

At the end of the study, Monica found a job in the same Swedish city working as a foreman for a construction company. Her work combined being an environmental coordinator and a quality assurance coordinator, and Monica led a team of carpenters in their work. In an email, she wrote that she had taken to the job "like a duck to water" and felt that there was a lot of opportunity for her to engage in personal and professional development, and that her job was interesting and engaging.

Peter

Peter's motivation to study construction engineering came from a desire to have a "wide education." Several participants in this study noted the importance of a wide education (see Danielsson, Gonsalves, Silfver and Berge: The pride and joy of engineering? The identity work of male working-class engineering students, submitted), which we have interpreted as a broad exposure to subjects that can open up numerous job opportunities and career directions. When asked why he chose specifically construction engineering at Swedish University, Peter explained that he was doing what his friends were doing. He did not wish to pursue a Master of Engineering as it is a 5-year program and he was interested in learning a lot in a short period of time. Unlike many students in his program, Peter never aspired to a career in construction engineering:

> It's not my dream, actually. But I have always wanted to study at a university. And after five years of work I felt it was time. And the decision to study to become a construction engineer is actually because of two friends that have studied construction engineering and liked it. But it is all only because I want to study at a university, I think it is a good thing to show, to have a paper as a proof that I can learn stuff. (INT P).

Thus, construction engineering was a means to an end for Peter, a way to earn a diploma in an area that had a broad application.

At the end of the study, Peter had found a job working as a foreman on a project that oversaw the construction of numerous condominiums. He acted as a support for the craftsmen on the construction site; led, planned, and distributed work; coordinated materials; and was in charge of following up and delivering projects. By email, he suggested that he enjoyed the work, but "struggle [d] with the group dynamics." He anticipated a time when he would be further in his career, have more experience with group work, and "feel safer" in terms of his job security. Peter indicated that he wished to have a more administrative role but has found himself taking on a great deal of practical work, which he hoped to move out of.

Dominant subject positions in the figured world of the engineering education program

The figured world of the engineering education program was mediated by the prominence of group work and a major group assignment which lasted over half the semester. The groups were quite large, at time up to nine students, and the group leader was decided by members of the group. The goals of the project were to connect theory with practice. Students did readings about how to construct different types of buildings (for example, one case was a sports arena) and then they visited relevant construction sites and interviewed the people working there. The last part of the group assignment entailed writing a final report describing their specific project and analyzing if and how the practical work at the construction site was guided by the theories they had studied. Authentic practice is purportedly modeled in these group assignments, as students are required to work together to solve problems and produce a report. Group assignments are meant to model the social dimensions of engineering, although students seemed to deal with the assignment through a divide-and-conquer approach, where each student took on one portion of the project and went away and worked on it individually, with varying degrees of success. In this way, the construction engineering education program produces a figured world that is modeled on the practice of engineering in the workplace, with a division of labor, and emphasis on the development of social as well as technical skills that emulate workplace practices.

Emerging from this figuring are two dominant subject positions for construction engineers in the education program: the "*brunker*" and the *competent engineer*. Each of these is constructed by and makes available resources for identification that shapes students' participation in the education program and the workplace culture. At times, these subject positions enabled participants to author themselves as untroubled engineering students who "fit in" to the classroom or workplace culture in recognizable ways. At other times, these dominant subject positions were troubling to students.

The "brunker"[3] is best described by Peter, who depicted a construction engineer student as a "very unaware man who, as he believes, must fulfill that male role in order to find some value or find some purpose or the like. [They] still live in a world that existed sometime far behind in time" (INT P). We have not identified an English equivalent to this term but suggest that this is a specific type of "engineering lad": a brawny male who enjoys working out, engaging in sexist jokes and *laddish* behavior (e.g. Willis, 1977). In the engineering education classroom, the brunker is a person who counters attempts to be "inclusive and open" by engaging in "classic male pig jokes" and "who is

sitting with his iPhone, and then he laughs and stretches over an Instagram image that says something like [...] women should be in the kitchen or something like that" (INT P). Monica also described brunkers in the class, suggesting that "they are like, they stick together [...] they work out at the sport centre and they, eh, study together as a gang" (INT M). Monica went on to describe an example of one of the "boys" from her class that all of the students look up to who is "a cool guy. Well not like, yes, but he has played football at a high level and he [exhales] I don't know why they look up to him really, because everyone is as cool, I think" (INT M).

The "brunker" subject position emerges as a variant of "the lad" helpfully described by Francis (1999) as a male who engages in "hedonistic practices [...] for example, 'having a laugh', alcohol consumption, disruptive behavior, objectifying women, and an interest in pastimes and subjects constructed as masculine" (p. 357). Jackson, Dempster, and Pollard (2015) further elaborated this position, finding that students described as lads tended to be "loud and attention-seeking, confident, into sport, popular, jokers, often heavy drinkers and sexually promiscuous" (p. 303). The lad, as described by Willis (1977) referred initially to white, working class boys. However, Francis (1999) has expanded this definition to include appropriation by middle-class males and has pointed to evidence that the definition of lads expands beyond social class and ethnic groups. Jackson (2002) has described how "laddish" behavior is often linked to underachievement and may function as a "self-worth protection strategy" used to insulate lads from the consequences of academic failure. These strategies include procrastination, avoiding the appearance of working, and engaging in disruptive behavior—all of which we see exhibited in the brunker variant of the lad typology. Engineering education research has described various formulations of laddish behavior, notably an emerging upper/middle-class form of laddishness that seems to attempt to appropriate working-class laddish behaviors (e.g., Stentiford, 2018). We suggest that the brunker is a subject position specific to the Swedish context and appears to be adapted to the construction engineering education context. Importantly, when asked if he saw any examples of the brunker on the construction site he visited as a field experience, Peter emphasized that this subject position is likely contained within the classroom, suggesting "I have not experienced that on the construction site. Nowhere [on my field visit] did I see someone behave like that" (INT P). Notably, this subject position is most described in the context of the figured world of group work, where students are expected to work together and, in some ways, reproduce the social dynamics of the engineering workplace. We thereby suggest that the

brunker subject position is one that may be linked with students' perceptions of dominant subject positions in the construction engineering work place. Paradoxically, but not surprisingly, the brunker is constructed in opposition to the competent student, another dominant subject position in the context of the construction engineering education program.

The *competent engineer*, as described by the participating students, is someone who is ambitious, technically proficient, and committed to group work. Group work, however, as Monica described, often entailed dividing tasks and performing them individually, and ensuring that they are communicated effectively: "We have been quite clear […] that everyone should be involved, and understand, once you've split it up, the others will need to understand what I've done" (INT M). Thus, competence in this case also entails being able to work independently, and doing a lot of independent reading and writing, in order to develop communication skills. The students in this program rarely spoke about engaging in any kind of engineering problem solving or construction; rather, they spoke more often about copious reading and learning about how to "refine what's available" (INT P) without actually needing to invent something new.

Besides their research and communication skills, the competent construction engineer was also understood as technical, and having a natural aptitude for working with computers and building. As Monica suggested, working with technology is "like running water" (INT M) for many of the students in the engineering education program. Monica described these skills as competencies that she was "so envious [of] that I'm going to pieces" (INT M). Similarly, Peter suggested that engineers likely "know a lot about how machines work […] or know how to build things" (INT P). Notably, the dominant subject position of the competent construction engineer aligns with a form of technical masculinity strongly associated with engineering (Faulkner, 2007; Wajcman, 1991). Wajcman (1991) described how this technically competent masculinity is based on toughness and physical skill. The strong relationship between masculinity and workplace technology emerged in the engineering profession (Cockburn & Ormrod, 1993) and thus typically positions men in untroubled ways in relation to this form of technical competence. As Wajcman pointed out, "muscles, skill, strength, dexterity, rationality and labour time become the preserve of men and important power resources" (Wajcman, 2006, p. 780). The dominant subject position of the competent construction engineer, then, is aligned with expectations for the Bachelor of Engineering programs generally, which are focused on the use of existing technology and its applications, rather than

research. Furthermore, it is also aligned with a form of technicist masculinity most often unproblematically associated with men. Overall, students in this program are able to position themselves as competent and author identities as engineering insiders when they can draw on skills as technically-oriented people, work well independently, and be recognized as technically competent.

The figured world and dominant subject position of the construction engineering workplace

Students' narratives of their experiences in the field invoked a figured world of the construction engineering workplace as harsh, dirty, and cold, a place for tough "real men" that required bravery and stamina. This figured world emerged from students' visits to field sites during their programs, and their field experiences as interns. The figured world of the harsh engineering workplace promoted a dominant subject position of the construction engineer as "brave" (INT L) and "heroes" (INT P) who could withstand the elements, arrived at work early in the morning, and did not care for comforts like cleanliness. Layla described the brave hero as someone who might "go up and down a ladder many times … and for them it's only: 'what could [possibly] happen?'" (INT L), indicating that brave heroes take a laissez-faire approach to situations that could be potentially dangerous. Peter talked about the "gruesome" conditions construction engineers endure, particularly the cold and the elements. He said, "they are damn heroes, you know, those who are outside doing it" (INT P).

This figured world also promoted a dominant subject position of "the really male man" in the engineering workplace. This subject position is associated with finding sloppiness or dirtiness acceptable, like "eating from the same fork every day without washing it" (INT L). Layla described encountering this subject position while wiping down a table in a common area as "really male men" sat around it, "and they just sit and laugh and then they lift all their stuff, yes, but can you, like, keep on cleaning here?" (INT L). This subject position is distinct from the laddish behavior that defines the classroom "brunker," but it similarly derives its power from hegemonic masculinity (Connell, 2005). We emphasize that these subject positions emerge as stereotypical forms of masculinity that engineering students associated with men who worked in the field site. These appear to emerge as dominant subject positions in the figured world of the construction engineer workspace because of their imagined qualities. Although the students spent varying amounts of time in the field sites and their experiences were relatively short-lived, they came away with

strong notions about the dominant subject positions that figured the world of construction engineering. As a result, we saw that all three students engaged in troubled positioning in relation to these dominant subject positions in different ways. Layla and Monica experienced episodes of being positioned as Other to the "brave hero" and "real men," while Peter struggled to author himself as an engineer that fit in to that landscape.

Students' identity work in relation to the figured worlds and dominant subject positions of the engineering education program and workplace

In the construction engineering education program, the various dominant subject positions that emerged both in the classroom and in the workspace were both troubled and untroubled for the participating students. As they were positioned around these dominant subject positions, students vectored toward or away from identities as insiders to construction engineering. We argue that this inconsistent vectoring formulated their peripheral identity trajectories into construction engineering (e.g., Wenger, 1999). We use the term peripheral trajectories to imply that these unconventional students moved through the figured worlds of the construction engineering education program and workplace in ways that permitted them to maintain career trajectories into engineering, but in ways that entailed troubled positioning in relation to the dominant subject positions of the figured worlds. In each students' narrative was evidence of "vectoring" in relation to their troubled/untroubled positioning around dominant subject positions they encountered (Brickhouse et al., 2006).

Layla: a "typical girl construction engineer"

Layla's identity work in the construction engineering program was characterized by a mostly untroubled positioning as a competent engineering student. Her interview revealed that her original goals were to pursue a degree in architecture, however, upon determining that she would not have the grades for architecture, Layla began to focus on construction engineering. To author herself as an insider, she claimed to think of herself as a "typical construction engineer" because she has always had this interest, but she also believed that "I've been like, if we say, three years with a class of 80% just guys, like, I'm used to it, and that's normal for me. I feel that I'm a typical girl construction engineer" (VD L). Layla's video diaries suggest untroubled positioning around the dominant subject position of competence in construction engineering. Layla described her participation in the group project as strongly independent yet entailing sharing ideas with others. Layla suggested she worked well in the group project scenario where the work is split up

and "every person takes a part, and one must learn about the part you took" (INT L). She felt she had the requisite knowledge from previous courses, and the group dynamics were "terrific, like. Everyone just wanted to finish their part" (INT L). From her descriptions, Layla seemed to engage easily with this kind of group dynamic that required little interaction and a great deal of independence. In this way, her untroubled positioning around the dominant subject position for competence facilitated her vectoring toward an insider identity as a construction engineer student.

However, Layla's workplace experiences complicated her trajectory. Layla spent a summer on a work-study experience that she attained through the university. During this time, she found that she had to author herself as a 'typical girl construction engineer' in new ways. On the construction site, she faced many hurdles, including hard physical labour and the discomfort of being a woman in a worksite dominated by men. Layla described that men had it easier, not having to worry about hiding away in an office to get dressed and being able to shower in the facilities. Where Layla did her field experience, there were no changing rooms or showers for women, and she described having to get changed in a colleague's office. These instances augmented her sense of "being the one girl" (INT L), a discourse that was repeated frequently throughout her interview. Archer, Moote, Francis, DeWitt, and Yeomans (2017) have described 'exceptional' girls who perform possible physics and engineer identities by positioning themselves as 'different' from other girls, and in doing so, distancing themselves from traditional hetero-femininity. This phenomenon has been described elsewhere in relation to physics and engineering (e.g., Gonsalves, 2014; Jorgenson, 2002; Tsai, 2004; Walker, 2001). However, Layla did not seem to be resisting femininity or 'Othering' women (e.g., Tsai, 2004) as much as she was attempting to position herself as singularly belonging to construction engineering.

Despite this resiliency, Layla's description of the men at her field site revealed much about her figuring of construction engineers as "brave heroes": "I've been working this summer, and I became physically tired. If I was a guy, it would not [affect] anything, because I worked with guys, it's only me who gets tired. Because I know I'm weak" (INT L). Layla assumes in this quote that men working on the construction site would not get tired, because of the strength she attributes to their maleness. She is thus positioned as weak in relation to the men working on the site, a positioning that was augmented by her coworkers' comments about her: "they were kidding me a lot, they thought I would not [make it], and they saw me like this [inaudible] I have nothing manly, I was like this, eh, little girl. They did

not think I would continue, like. They thought it was funny" (INT L). Layla suggested that these comments came mostly from the older men, implying that this is an older mentality among construction workers. Thus, Layla's positioning around this dominant subject position was troubled, and seemed to vector her away from an insider construction engineer identity. To compensate, she described hoping for an office job that would allow her to work inside, arguing that the work experience "showed me what I wanted. Like, now I know I do not want to work outside, I want to be here in an office, for example. At the beginning I did not know, and I was unsure so I felt like I had to experience how it is..." (INT L). This experience made Layla realize that she would need to position herself as competent in the office in order to persist in the field, so that she would not need to work outside: "I think when it's cold, when it's dark […] I feel a bit weaker, so I will not want to work outside" (INT L). At the time of the interview, Layla was looking for "office work, like something in the heat," she said with a laugh. Layla described office workers as "a bit more classy". Although she did not have experience working in an office setting, she was confident that she would find an office job because they need women in the field.

Despite these experiences and comments from co-workers, Layla argued that construction engineering is good for women and girls to consider entering. She suggested that construction engineers are looking for girls. I have checked today on an ad, job advertisement. They have written at the end, eh, we look forward to getting more women as well, so they want women. They want. I have been to many different companies, and everyone says that we want girls. (INT L)Layla described being told by an instructor in her program that "I will guarantee you get a job, even if ten other guys are looking for experience, they will [hire] you because you are girl, there is no girl there" (INT L). Thus, Layla had strong ambitions to continue in construction engineering, even though she faced sexist jokes during her field experience and felt that she was "too weak" for the job in relation to her male peers.

Throughout the program, and as she projected into her future, Layla's identity work as a *competent student* and a *typical girl construction engineer* was leveraged to secure herself a recognizable position both in the engineering classroom and the workplace. Layla's trajectory was made up of moments of vectoring toward an insider identity for a construction engineer student (e.g., untroubled positioning around the "competent student" subject position), but her encounters with the dominant subject position of the 'brave hero' in the work place were troubled and positioned her as weak and inappropriate for outside work, thus shifting her identity trajectory peripherally.

Monica: "thick skinned" and adept at coping in a male dominated workplace

Monica struggled with a troubled positioning in relation to the competent engineer subject position associated with the education program, particularly the requirement for technical skill and an aptitude for working with computers. She described this form of competence as something that comes naturally to some, but not to her:

> For my part, I do not have so much knowledge about computers, I will learn something new with the computer every day [...] and then there are those who just, it's like running water. So, I'm so envious that I'm going to pieces. (INT M).

Monica emphasized that she was in the program to learn, but she did not come by the learning naturally as other students in her program did, and often if the lesson went too quickly "then I cannot follow, if it is something I don't know about" (INT M). However, Monica authored herself as skillful in new ways in relation to group work in the program. She suggested that she has "social skills" that engineers do not typically possess, and she regarded these skills as professionally useful and important because "all of us need to get out and work with people. Even though we are engineers, we will work with people as well" (INT M). She recognized that engineering is a field which requires social as well as technical skills (Faulkner, 2007), and thus attempted to author herself as competent by emphasizing her social skills. However, the success of this identity work was not consistent, as she described: "Well, I talk a lot and I like to get to know people and keep on going" which occasionally became problematic for her in the context of group work, when she found that "not everyone is open and wants to talk and [some] are little more reserved and like [to do their] thinking [on the] inside"[4] (INT M). Thus, Monica's positioning as the socially skilled engineer did not always have value in the group context, where individual work and thought had a stronger value.

In Monica's interview and video-diary entries, she demonstrated a frustration with the gendered expectations that emerge in the group work context. When describing herself in relation to the others (males) in her group, she said, "We are definitely not similar in any way, any of us" (INT M). In her group project, there were "two girls and seven guys. For me it does not matter but, you notice that, yes there's a difference. We girls are a bit more sensitive and like to show emotions when we discuss our writings and so forth" (VD M). Although Monica claimed that these gender dynamics do not "make a difference" (INT M) to her, she did take a more troubled stance in relation to the brunker subject position that emerged in her group's dynamics. Monica said

that the "guys" in her project "stick together," although she conceded that it was "not as though they are a closed group. So, it's not so that you're 'ah, shit, there they are, I cannot go there. Or maybe someone feels it like that, but I do not feel so because I'm very, too, feel, um, I'm not going to say like a mum, but I do not feel shy to go forward or something" (INT M). When Monica came up against the brunker in the context of group work and the classroom, she adopted a challenger strategy (Kvande, 1999) to distance herself from the norms for participation that the figured world of group work can perpetuate. Rather, she vectored around this subject position by authoring herself as "the Mum." For instance, she compared herself to her peers by claiming, "sometimes when they talk about going for a drink at the pub, or you know, things like that, partying after a big test, or...You just, 'oh, I want to go, too', no. I go home and do as I usually do - eat tacos with the family and drink a glass of red" (INT M). In the same way that she did not engage with "brunky culture" in her education program, Monica also did not engage with the gendered discourses that positioned women as different or inferior in the engineering education program. When asked about what it was like to be a woman in a male-dominated learning environment, Monica claimed to mostly ignore the issue:

> So, I do not want to say, we have, I have no problem with that when it comes to my study class [...] We have different feelings. Just because we are fewer, we are inferior, or should feel that we are, in a way? That does not occur in my world. Or, it does occur in my world, but I do not put any energy in it. (INT M)

By "not putting any energy in it," Monica did not directly challenge this discourse, and did not engage in any kind of positioning that might refigure the world dominated by the subject position of the brunker and the association of the competent engineer with masculinity. Nor did she work to change the discourse that women were inferior in this context. Instead, Monica's identity work as "the Mum" helped her to navigate these discourses in ways that facilitated her peripheral trajectory in the program and in the construction engineering workplace.

Much in the same ways as Layla constructed a peripheral identity trajectory by ignoring the comments of the men in the workspace and persisting onwards, Monica also faced what we interpret as sexist comments from the "older men who work in the construction agency" (INT M). She recounted several instances of sexist comments in the form of jokes (described in Silfver, Danielsson, Gonsalves, and Berge: Troubled and untroubled positions: Female students' narratives about engineering workplaces, in preparation) but positioned herself as thick-skinned in response:

> I can take, I realize that it was like a joke, but it's a bit like that, aimed at, against women like that. And since now, I have met some older people and they, they are really old, I was about to say, men who will soon retire. They, you know, they almost looked at me with sadness in their eyes and just why have you chosen to work in this business? (INT M)

These findings are in line with Jorgenson (2002) who has suggested that women working at construction sites are particularly vulnerable to explicit teasing and harassment. Jorgenson described the kinds of sexist and belittling comments from male colleagues as attempts to challenge women's professional legitimacy. Monica confirmed these kinds of interactions, suggesting that these comments may come from men who believe that the industry and workplace is not fit for women:

> They think it's a dirty business, or that they think it's like […] that it's not fit for women […] but I do not know […] They think we do not have anything there to do. But I will not tolerate that, so I will not, yes, yes. I'll have to take it when it happens. (INT M)

Despite her distancing from the sexist discourses of the workplace that positioned her as an outsider, Monica strove to fit in. She adopted a "thick skin" mentality, though suggesting that she worked hard to vector towards a position as an insider. "It took a couple of weeks and I needed to try quite a bit to, to, eh, what should I say, not be accepted, but because I would like to be one in the gang as you say" (INT M). This desire to position herself as an insider to construction engineering could also be seen in Monica's description of why she decided to pursue this career. Monica's working-class background and previous work experiences have meant that she has always chosen job opportunities that can pay the monthly bills, not to gain status. She suggested that part of her reasoning when choosing a career in construction engineering was to not "'turn the coins' once the month is over'" (INT M). However, while a steady income was an important factor, Monica said "the biggest driving force has probably been to become something" (INT M). Thus, Monica strove for an insider engineer identity and the possibility to gain social status through her new positioning as an engineer.

Peter: the desk worker who is all thumbs
Peter was positioned in both troubled and untroubled ways in relation to the dominant subject positions of

the engineering education program, and the workplace. Like Monica, Peter also struggled with the dominant forms of competence in the program, and had difficulty authoring himself as a competent student:

> If you say, one half of my class maybe, have worked in construction. Eh, I have my own thumb in the middle of my hand.[5] And a classical construction engineer I would say has an ambition to become, or a dream of becoming a construction engineer, engineer anyways. I do not have that. (INT P)

This association of technical competence with engineering led to a troubled subject position for Peter, as a result claims that he is "definitely not sure it's a construction engineer I want to be" (INT P). Rather, Peter said laughingly, he would "feel most confident inside the office, because I have, I do not feel I have the experience required to specifically, to make it safe" (INT P). Thus, Peter vectored away from the subject position of the competent engineering student and instead authored his construction engineering identity in line with the social aspects of the discipline, which may entail office work, managing people, and project work, rather than skilled manual labor.

This positioning was also influenced by the social aspects of the engineering education. At school, Peter authored himself in contrast to the subject position of the brunker, whom he described as "a very unaware man" and whose behavior he characterized as "unnecessary" (INT P). However, despite his dislike for the brunker, Peter did not position himself in troubled ways in relation to this dominant subject position, because the behaviors of brunker do not seem to impact him in any significant way, nor does he need to author himself as a brunker to gain recognition as an engineer. In the interview, he suggested "I am not responsible for their stupidities in any way" and went on to recommend that in the figured world of engineering education, "one must try to be as inclusive and open as possible" (INT P). While he was critical of the brunker and he felt that "[the brunker behaviour] feeds a kind of something […] brunky culture," Peter conceded that, to him, the brunker is "no great violation" (INT P). Peter simply vectored away from it and maintained a peripheral trajectory throughout the program—not engaging with the dominant subject positions around technical competence and the brunker masculinity but persisting through the program nonetheless.

Peter encountered troubled positioning in relation to the dominant subject positions for both the construction engineering worker and the figured world of the construction engineering workplace. Although Peter only visited construction worksites fleetingly, as part of his field experience, he had constructed a figured world that was cold and "gruesome" (INT P). When asked to describe the work, Peter suggested that the work was "[n] othing I would like to do, I think. Maybe a while just to learn" (INT P). Peter's troubled positioning in relation to the dominant "brave hero" subject position led with a preference for inside work, in particular office work that might allow for flex time. He said, "it is not the dream, but it is close to it" (INT P). This desire to work in the office means that Peter would, much like Layla, need to position himself as skilled in the more social aspects of the engineering profession. In many ways, Peter's identity work in the construction engineering program can do much to refigure the traditional technical/social dualism so strongly present in the discipline (c.f., Faulkner, 2007). Peter suggested that being a construction engineer came with "some responsibility not to be the classic man at a construction area" (INT P). However, when pressed to explain where you would see the "classic man," Peter described it as a dominant subject position present at the construction site rather than in the office. Thus, Peter's identity work in relation to the dominant subject positions available at the construction site was troubled in ways that influenced his trajectory into an engineering job. In his video diary, Peter said that he had "no solid plan" for his career, but in a follow-up communication with him, he reported that he was a foreman on a construction site. Thus, while Peter maintained a peripheral trajectory throughout the engineering education program and in his engagement with field sites, he managed to carve a position for himself by vectoring around the troubling dominant subject positions that interfered with his identity work.

Conclusions and implications

In this article, we presented the positioning and identity trajectories of three "unconventional" students in a construction engineering program. These trajectories might be each characterized as peripheral, based on the vectoring that students do around the dominant subject positions in the program. We discuss vectoring, rather than just trajectories or positioning, in order to highlight the movement toward or away from insider identities that occur throughout the students' experiences both in the figured world of the construction engineering classroom and the figured world of the workplace. We suggest that this vectoring occurs as students are positioned or author themselves in relation to *dominant subject positions* in the program and the workplace. Vectoring has been described as an alternative form of identity production to the smooth arc of an identity trajectory (Brickhouse et al., 2006). Brickhouse et al. (2006) suggest that:

students start in different places and move in more or less zigzag fashions; motions to the left, for instance, are met by cultural expectations that send the student back to the right somewhat, and at each turn aspects of an individual can be shucked off (or not made visible), while new accommodations are taken up, and so on. (Brickhouse et al., 2006, p. 322).

Brickhouse et al. (2006) argue that in engineering education, men and women seem to vector differently—often women vector around subject positions so peripherally they may end up off the map, whereas men can vector to various places around dominant subject positions that each connote a different form of belonging but generally entail membership in the group. In this way, vectoring as a form of identity work is reminiscent of Jackson and Seiler's (2013) suggestion that identity work in science learning happens in moments of increased or decreased velocity toward science identities. Taken together, these moments result in a momentum that occurs as a "buildup of resources that creates a patterning or thickening of identity" (p. 831). The concept of vectoring helps us to characterize this increased or decreased velocity, specifically around dominant subject positions. We recognize, however, that there are limitations to the applications of this term. While it is possible that participants may vector toward or away from different subject positions, this vectoring may be a phenomenon that happens in context. In varying contexts (like classrooms, or workplaces), it is possible that same participants may at times vector towards and at other times away from the same dominant subject position. This suggests the temporal and spatial specificity of identity work, and indeed of the process of vectoring. We recognize this limitation in the emergence of this framing tool, but also regard this as further evidence that identities are done in practice, fluid and subject to change.

This study also expands on the work of Carlone et al. (2014) to reframe "celebrated subject positions" as dominant forms of cultural models present in figured worlds. The concept of celebrated subject positions is attractive, as they shape desirable identities for participants in a figured world; however, our findings suggest that not all of the subject positions around which students do the most positioning are celebrated. For example, the emergence of the "brunker" as a dominant subject position in the engineering education program is significant for students' identity work, but this position is hardly celebrated in the program. Thus, we retooled Holland et al.' (1998) concept of cultural models even further to identify dominant subject positions that "trouble" students' identity work (Wetherell, 1998). This theoretical retooling helped us see how important these subject positions were for students at the end of their educational program, as they were crafting identity trajectories into the workplace. This was a particularly crucial time for students' identity work as they considered their career trajectories in light of the dominant subject positions they had been exposed to during work study and field experiences. We saw that movement from the classroom to the workspace could be troubled by the dominant subject positions present in both figured worlds, thus impacting students' vectoring and ultimate trajectories.

As engineering programs in Sweden hope to recruit more and diverse students by providing authentic experiences (such as project work and field experiences), we see clearly how the discourse of the technical/social dualism so prevalent in engineering workspaces (Faulkner, 2007) figures students' experiences as they move across figured worlds. Students are encouraged to solve problems in group work, yet a "divide and conquer" orientation (Kittleson & Southerland, 2004) figures students' approaches to studying, resulting in a strong emphasis on individual work. This works well for some students, especially those whose identity work is in conflict with the dominant cultural models in the figured world of engineering education (i.e., the brunker), but presents problems for transitions to workplaces for others. We saw students like Layla and Peter leveraging this "divide-and-conquer" activity in their choice of engineering career. Both participants indicated that construction engineering was not their first choice for career, or that it was "not [a] dream" career, and both indicated that aspects of the job were intimidating to them. Our analysis suggests that they both wish to pursue office jobs so they may "hide" from the very masculine cultural aspects of construction workplaces that marginalize them. For Layla and Peter, this does not mean that they are drawn to the social aspects of engineering office work, but rather that they seek "desk work" in the comfort of the indoors and away from the cultural models of masculinity that predominate construction engineering work outdoors. However, office work in engineering is not individualistic (e.g., Trevelyan, 2010), and Layla and Peter both discuss the need to be more skilled in the social aspects of the discipline. The value that Layla and Peter place on competence in the office suggests that more attention be paid to building professional skills into engineering education curriculum.

This study points to the importance for university teachers and engineering programs to follow up on students' field work experiences. This recommendation is supported by research on students' professional identity development suggesting that explicit opportunities to reflect on their professional experiences (through the engineering program and through workplace experiences) contributes to students' self-efficacy and sense of self as engineers (Eliot & Turns, 2011; Turns et al.,

2012). The outcomes presented here suggest that students' social and professional learning (including reflections around norms and behaviors in workplace settings, and challenging troublesome subject positions like "the brunker") may be as important to students' identity and career trajectories as the conceptual and procedural learning they do in workplaces. To situate this finding, we recall Erwin and Maurutto's (1998) study of undergraduate women science students who could not find their way out of individualistic discourses that positioned them as struggling students, even in the face of structural obstacles. The study concluded that few students knew of strategies that could help them to cope with the barriers they confronted in their education. We suggest that engineering educators cannot expect students to unproblematically learn to be engineers in the workplace while on field experiences or engaged in service learning. If engineering practices are to be transformed, students need resources or tools to help them develop their professional skills, but also to cope with workplace experiences that may be marginalizing them. Finding ways to support students' sense-making of these workplace experiences may be critical to their well-being, rather than attributing their feelings of marginalization to their own individual shortcomings. The transition from classroom to workspace is under-researched in engineering education (c.f., Dahlgren, Hult, Dahlgren, af Segerstad, & Johansson, 2006; Gallagher, 2015), and we suggest that longitudinal data tracking students from Bachelor of engineering programs, through field experiences, and into workplaces may give insight into how these worlds of engineering may be refigured and reimagined as students move through them on inbound, outbound, and peripheral trajectories.

Endnotes

[1]To ensure confidentiality, we have not identified the region in Sweden where this study was conducted, and assigned the research location the pseudonym 'Swedish University'

[2]Authentic stories collected from different university websites, see Berge et al. (2018).

[3]The term brunker is translated to English from the Swedish "brunkare" which is an uncommon term used to describe a jock, particularly one who plays hockey with an aggressive style of play. Peter uses it here to describe the particularly local form of laddish masculinity (e.g., Jackson, 2002; Willis, 1977) present in the construction engineering culture. Brunkare does not appear to be a well-known slang term in Sweden among people outside of the millennial generation.

[4]Edited for translation.

[5]"Thumb in the middle of my hand" is a literal translation of a Swedish idiomatic expression equivalent to the English "I am all thumbs."

Additional files

Additional file 1: Questions guiding Video Diaries (Translated from Swedish). (DOCX 16 kb)

Additional file 2: Interview Guide. (DOCX 15 kb)

Availability of data and materials
Data will not be shared due to restrictions in the Swedish Research Council guidelines for anonymity and data security ethics under which these data were collected.

Authors' contributions
All authors contributed to the investigation and the drafting of this manuscript. AG analyzed data and wrote the manuscript. ES collected some of the interview data, contributed to the analysis with AG, and reviewed several drafts of the manuscript. AD collected some interview data, made classroom observations, contributed to manuscript writing with AG, and reviewed drafts. MB (PI) conducted interviews and classroom observations and reviewed drafts of the manuscript. All authors reviewed final drafts of the manuscript and approved for publication.

Ethics approval and consent to participate
All participants agreed to and signed informed consent forms (available if requested). The project follows the Swedish Research Council's guidelines for anonymity and data security. This means that the names of teachers and students will be anonymized in publications. All material will be saved for 10 years and then destroyed in accordance with current research ethical guidelines. Swedish universities do not have local review boards, and projects that deal with sensitive information about people (in Sweden this entails research about religion, sexuality, political opinions, and union membership) are sent to one of six regional ethics review boards (https://etikprovning.se/). However, since this project does not deal with sensitive information, it did not need to be sent to the regional ethics review board, as per Swedish Research Council guidelines.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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