Investigating Engineering Practice Using Ethnographic Methods: Experiences of Student Observers at Multiple Field Sites

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Introduction

Research on engineering practice involves unique opportunities as well as challenges. On one hand, those seeking to study the day-to-day realities of engineering work may find themselves in a relatively wide-open field of scholarship where new methods can be used to address emerging questions and leading-edge issues. On the other hand, scholars of practice frequently face difficulties not encountered by those who study more conventional engineering education topics (e.g., teaching and learning in traditional classroom settings). For one, the nature of practice is always and rapidly changing due to the evolving nature of technical work, driven by factors such as organizational restructuring, digital transformation, and pandemic-associated disruptions, to name just a few. Further, simply gaining access to study participants and field research sites can be difficult, along with associated issues such as identifying suitable data collection and analysis methods, securing approvals to carry out research with human subjects, and effectively communicating results to academic, industry, policy, and other audiences.

This paper reports on a research project, supported by an NSF EAGER award, that explores innovative ethnographic research methods for studying engineering practice. Here we primarily focus on the experiences of three students who were directly involved in our data collection efforts. One undergraduate student engaged with one field site (a utility company, "UtilityCo") through job shadowing and informal interviewing, while two graduate students collected data as participant observers at a second site (a small software start-up, "SoftCo"). In this paper, our primary research objective is *to examine how these three students experienced their roles as participant observers, including in terms of the learning and insights they reported gaining*. In our findings we more specifically examine: whether and how this experience impacted their views on technical work practices, their own educational experiences, and their future career goals; their perceptions about the value of learning participant observation skills; and variations in each student's interests and foci in conducting observations and collecting field data.

As background for this account, we additionally mention other issues such as how our team trained the students to function as participant observers and gained access to field sites. Beyond illustrating the procedures and potential benefits associated with our distributed data collection efforts, we experienced the turmoil of conducting field research on engineering practice, including issues around gaining access to people and other sources of evidence, changing goals within partner organizations, and identifying primary informants, among others.

Characterizing engineering practice is a difficult undertaking, especially given rapid rates of change and significant cross-sector differences in work roles and expectations [1]. Further, employers expect engineering graduates to be prepared to enter the workforce, but academia does not always have a clear picture of contemporary workplace realities. Indeed, debates persist about the extent to which students should be trained for specific fields or job roles versus prepared more holistically for unpredictable futures as professionals and citizens. By expanding the capacity to study engineering practice through students serving as participant observers, we propose that academia can learn more about the engineering workplace while students gain a

truer understanding of engineering work. At the same time, reflectively engaging with practice may help students develop new professional competencies, while potentially also identifying misalignments between their own identities and goals, on one hand, and current educational and workplace realities, on the other. This paper will likely be of interest to researchers who study engineering practice, and especially those concerned with the full range of practical and methodological challenges associated with collecting and analyzing data in industry/workplace settings. Additionally, our work speaks to the role and benefits of self-reflection in learning among technical professionals.

Literature Review

As Stevens *et al.* [2] note, research on engineering practice often utilizes field study methods, with interviews and observation predominant as data collection approaches. Most field studies have a broadly ethnographic goal, namely to adequately and "thickly" describe the nuances of practice, to understand and represent the meaning of those practices for participants, and to understand unique and locally situated forms of work culture and social organization. As summarized elsewhere [3], some of the earliest works in this genre were published in the 1960s and 1970s, followed by a new wave of studies carried out from the 1980s to the present, and in part linked to growing activity in emerging fields like Science and Technology Studies (STS), Engineering Studies, and Engineering Education. Many studies were conducted by individual scholars with graduate training in anthropology or other social science fields (e.g., [4]–[7]) or by engineers-turned-ethnographers (e.g., [8], [9]), and with varying degrees of direct observation and participation in workplace settings and practices. These and related works have generated a wealth of insights about the nature of technical work (e.g., [10]), but rely on wide-ranging and long-term research efforts that are very time and resource intensive. Methodologically, most field studies of engineering practice have followed long-standing traditions of ethnographic research that emerged from anthropology and sociology. In this paradigm, placed-based long-term immersion at a site, sometimes over years, was the standard approach. Yet, the nature of engineering has changed dramatically in recent years where engineering practices are not as place- nor time-bound as they once were.

This in turn begs the question of how to potentially scale up the capacity for conducting ethnographic studies of engineering practice, such as by teaching participant observation methods to students and practitioners. Increasing data collection capacity, especially across organizations and sites, is critical for being able to contribute to theory development, which requires a diverse but robust understanding of phenomena of interest in the field [11]. Indeed, scholars have written about teaching participant observation in several settings with varied constituents such as hired field workers for classrooms [12], employees in requirements engineering [13], and systems engineers in a software business [14]. Further, ethnographic methods like participant observation are not new to engineering settings, and related work has been done in industrial design [15], web design [16], artificial intelligence [17], and digital systems development [18]. As a more specific example, Sharp *et al.* link ethnographic methods to engineering work by proposing "*ethnographic studies as a technique to study the community of software engineers and improve the way in which they work*" [19, p. 792, italics in original]. The authors go on to argue that "if software engineers undertake the ethnographic study themselves, then this can increase the likelihood of the findings being of use within an empirical

software engineering context" [19, p. 799]. Additionally, Zhang *et al.* [20] performed a systematic literature review of ethnographic methods in software engineering and created a checklist to improve the practice.

While these papers point to the advantages that ethnographic methods could have in studying engineering practice, some potential shortcomings are also identified in the literature. Employing ethnographic techniques is not necessarily straightforward. Training students to be participant observers is challenging because of the nature of the data being collected and the lack of clearly defined steps [12]. This may especially vex students in engineering and other technical fields where "rational" and "objective" paradigms of problem solving prevail, and where ambiguity, uncertainty, and contingency are at best avoided and at worst managed. And even if field workers are trained to an identified acceptable standard of research, the findings may be perceived as superficial or unreliable [21]. Another obstacle is gaining entry to the study sites and settings. Finding participants and companies willing to participate in an ethnographic study can be difficult for many reasons, including challenges associated with building trust with company gatekeepers, navigating intellectual property and other liability concerns, and offering a value proposition to the host unit or organization [22]. Ethnography is also typically bound to small, well-defined environments like classrooms or groups of people. Although researchers may want to deploy ethnographic approaches in larger settings such as companies, challenges associated with scaling up the duration and depth of interactions and observations can arise [23]. We allude to some similar issues below as we introduce our own project, including in relation to the settings we observed and observational approaches we employed.

Methods

Project Background

The NSF EAGER project supporting this research more generally aspires to explore innovative approaches to collecting, analyzing, and archiving empirical data related to engineering practice. In prior work, for example, we identified and reviewed a wide variety of digital ethnographic methods and appraised their potential utility for studying engineering work practices and engineering education topics [24]. We also proposed carrying out ethnographic research at multiple field sites representing different industry sectors and using a variety of novel methods (e.g., agile ethnography, trace ethnography, etc.). Our main goals for the current empirical phase of the project include: 1) developing a more nuanced understanding of contemporary engineering practice in specific organizational settings, and 2) critically evaluating different research methods, including by actually using them to investigate technical work practices.

Field Sites and Research Team

Gaining access to industry field sites and informants can be challenging, including due to concerns around having access to proprietary company data and intellectual property, risks of possible reputational harms, perceptions of limited benefits for the host site, etc. [22]. The investigators faced many of these challenges, and they were only compounded by the disruptions associated with the COVID-19 pandemic. Nonetheless, the investigators ultimately identified three host sites for the project, each with varying levels of access.

One PI explored data collection opportunities at two sites, namely a county engineer's office where undergraduate student researchers could directly visit and observe work at specific sites of interest (e.g., a wastewater treatment plant), and a large, regional utility company ("UtilityCo") where students could essentially "job shadow" day-to-day work in online settings (e.g., team meetings), conduct interviews with key personnel, and visit field sites where projects were being carried out. As we discuss below, the utility company was ultimately the more successful site. Two students were initially engaged with data collection efforts at the first site, but one student left the position to take another opportunity. The remaining student, who we refer to as Intern Z ("IZ"), was a non-traditional undergraduate student with a previous degree in English and was pursuing a second undergraduate degree in civil engineering. IZ was in their junior year and had extensive prior experience doing paid work as a transcriber. IZ carried out observations and fieldwork over a period of ten weeks during the summer of 2021. On average, they spent about ten hours per week collecting data, writing up field notes, and updating the research team on their progress. They also did nine follow-up interviews with technical and managerial staff at the company during Fall 2021, after their observation period concluded. The data collection goals communicated to IZ were broadly concerned with studying the nature of engineering practice and the day-to-day experiences of engineers.

A second PI initially looked for opportunities to collect data in large corporations where they had pre-existing contacts. As these efforts failed or stalled – likely exacerbated by COVID-related disruptions – the PI finally gained access to a small software start-up that was willing to host students as true participant observers within the organization, more specifically acting as part-time (20 hour/week) software development interns. The interns were employed as graduate assistants on the original NSF grant and technically supervised by the PI, making this an attractive proposition for the company in terms of having access to entry-level software engineers without having to directly commit any financial resources. The associated PI was also given wide-ranging access to sit in on team meetings, interview key personnel, and observe and explore some of the key software platforms used to organize and manage the company's work (e.g., Slack, Jira, GitHub, etc.). Since the start-up did not have a physical workspace, all work tasks, observations, and interactions occurred entirely online/remotely. The research team for this site included three individuals. Intern X ("IX") was pursuing an MS degree in computer science and had previously earned undergraduate degrees in computer science and communications. IX spent approximately one year (from Summer 2021 to Spring 2022) as an intern at the company. Intern Y ("IY") was pursuing a PhD in computer science and held previous degrees in computer science and engineering (BS) and computer science (MS). They spent Summer 2021 as a part-time intern at the company. As noted above, the PI associated with this site was mainly an observer, but also assisted the firm by performing a usability analysis of the company's main software product and presenting a final report of key observations and recommendations. The interns and the PI signed confidentiality agreements with the company, and collected data under a human subjects research protocol approved by Purdue's Institutional Review Board (IRB).

Intervention/Approach

This paper is specifically focused on the experiences of the student researchers. In terms of recruitment, we sought to identify students who held and/or were pursuing technical degrees but were also open to the idea of learning and using social science research methods to study

technical work. To help prepare the students for their observational tasks, we developed and delivered a short training tutorial focused on ethnographic data collection methods, including activities to practice data collection in the field (see Appendix). The objectives of the tutorial were to introduce the idea of collecting data from the field and what constitutes the field, namely in our case the work of engineers in a specific organizational setting (a focused ethnography). Taking a holistic look at engineering practice in the field, the students were introduced to the elements of Activity Theory [25], which goes beyond the obvious technical tasks of an engineer at work to include the objectives and outcomes of the work; the use of tools, instruments, and symbols; rules and norms governing particular ways of working; stakeholder communities; and the distribution of work among teams of people inside and outside the formal organization.

We also asked students to read excerpts from *Field Notes* by Vivanco [26]. The chapter on taking notes provided guidelines and examples for the different ways researchers take notes and the different categories of notes that are useful, such as notes on actions, notes on talking and non-verbal communication, as well as notes describing the setting (sketches) and self-reflections on observations. We discussed these different approaches with the students and provided other examples. The tutorial was facilitated as a presentation and discussion introducing the practice of doing fieldwork and the focus on the different kinds of data important to this study, such as the people, communities, tools, rules, roles, and objectives of the engineering work they might encounter. The emphasis was on the diverse nature of work practices and the variety of data that could be collected, and techniques for producing field notes and conducting interviews. We discussed key points about the role of a participant observer and the overall goals of research as well as strategies and tactics for data collection and documentation. Following the introductory presentation/discussion we staged a practice run for the students to gather data from a particular field setting (e.g., public space like a restaurant, plaza, etc.) and met with them afterward to discuss their experiences, address their questions, and provide feedback. We also reviewed initial copies of field notes with the students to reflect on their experiences and provide feedback.

After a short period of orientation to their technical work roles within SoftCo, IX and IY were asked to practice and apply their observational skills by keeping field notes using a common format developed for the study (see Figure 1 below). They met with the PI regularly (typically every week) to debrief on their work activities and experiences, share relevant observations, etc. During the later stages of the project, the PI also had numerous e-mail exchanges and Zoom meetings with IX to discuss and clarify specific aspects of the observed software development work given that they spent a much longer period of time embedded in the company. IZ had a similar experience in terms of maintaining a log of field notes throughout their time of observation with UtilityCo. IZ also had frequent virtual meetings with their supervising PI to discuss their progress and observations, and to talk about any concerns they might have had.

Data Collection and Analysis

The results presented in this paper are primarily drawn from semi-structured exit interviews with the three student researchers. Most of the questions we posed were aligned with our primary research objective, namely to examine how these three students experienced their roles as participant observers, including in terms of the learning and insights they reported gaining. One PI and the project consultant jointly interviewed each student via Zoom after their formal

commitments to the project had ended. Each interview was about an hour in length, was audio recorded using Zoom, and then machine transcribed using Otter.ai. The raw transcripts were edited for accuracy and anonymized by the second author. The first and second authors then read each interview and wrote 1- to 2-page analytical memos summarizing key topics, themes, and questions, with a focus on addressing the primary research objective. The two lead authors met to discuss each interview separately, and then iteratively identified and wrote up the themes and findings presented below. The findings were further reviewed and revised by the larger research team, who are all co-authors on this paper.

Observer: [IY]	**Setting(s):** Setting-up the environment	**Date(s):** 07/13/2021
Field Notes: ***Context:*** IY is trying to follow the instructions in the previous google doc and the instructions from this morning to set up the repositories locally and finish up the rest of the setup tasks. ***Place:*** Remotely (working from home using personal laptop) ***Who:*** IY ***When:*** Entire workhour of that day • Reviewed the google doc again to just stay focused on the priority of today's work. • Followed the instructions from this morning and dived into the code for two of the repositories to change the default port for development. • Having the guidance from LD actually made it easier and IY can now successfully run the repositories in development mode in desired ports. […]		• Unlike the previous works in the last few weeks, this work is a bit different. We were not provided with any Jira Card, rather LD provided us with a Google Doc that has lots of information in it. • In my personal view, I think this work has too many interdependent steps and details that it would be hard to break it down in small pieces and at the same time it is hard to write a very large amount instructions in a single Jira Card. […]

Figure 1. Sample excerpt from IY's field notes

Findings

Perceptions of technical work and relevance to prior experiences and future goals

All three students had extensive opportunities to observe various job roles and work practices, and both IX and IY were directly involved in technical work as full participants. We thus asked each student whether and how their experiences impacted their perceptions of technical work, as well as how it related to their previous and ongoing educational experiences. In response, IX reported that the internship changed their understanding of software development "by leaps and bounds." Particularly salient was how they related their education to the technical work they did. As IX said, "everything that I've learned in school, I essentially had to leave 80 to 90% of it at the door." This did not come across as an indictment of the technical education they received but rather as a "realiz[ation of] just how much of an amateur I am when it comes to software

development." More specifically, IX saw the "inner workings of an application in ways I hadn't seen before", including what a "mature sort of code base looks like," "how vast the code base can be," and "how many levels there are to building an application." When asked about gaps in their formal education, IX observed that they would like to have had a "seminar on the most recent technologies being used by industry professionals." Their perception of technical job roles also evolved through interactions with other members of the development team, and especially the lead software developer. IX more specifically noted "how much interfacing you actually have to do", including with customers and the company's other, non-technical staff. As they stated, "I never thought that, as a developer, you might be spending […] in the ballpark of an hour to two hours every day just talking to customers trying to figure out what they want."

IY also noted that the practice of software development was "very different from what I have studied in books […] or in class." While in their formal education they got the impression that companies followed strict development practices such as Agile, IY observed that the host organization did not always "stick to the book." Elsewhere, IY noted appreciation for getting real-world, hands-on experience with specific tools and methods they were already aware of and in some cases had limited exposure to (e.g., GitHub and various software testing methods and phases), as well as learning a variety of software tools and techniques that were new to them.

IZ, on the other hand, felt that their perceptions of engineering practice did not change much based on their observations, including in terms of who does the "actual" engineering work (i.e., lower-level staff). However, IZ appreciated having opportunities to practice "behaving in a professional way and, and interacting with a variety of people of various, you know, corporate levels." IZ also acknowledged that their eyes were opened to "the sheer scope of it all" and "how much coordination it takes" to get things done, especially in the regulation-heavy utility industry where they performed their observations. Finally, IZ noted that the experience was useful in terms of opening their eyes to various pathways into environmental engineering as a career (e.g., specific roles for environmental engineers in the energy and government sectors).

Perceived value of participant observation skills

During their debrief interviews, each student was additionally asked about what habits or skills they would take from their ethnographic fieldwork into their future professional roles. Both IX and IY noted that the experience was generally beneficial. As IX explained, "because I was constantly also reflecting on what it was that I was doing, um, I think it made me see myself as a programmer in a completely different light." IX additionally remarked how this unique role helped "bridge […] the gap between my two majors as an undergrad" (i.e., computer science and communications), and described how intentional observation and reflection became a kind of "habit" for them over time. IX described this as a "fascinating process" where they went from "not thinking about it, and then actually thinking about it without having to make any effort at all, and, you know, sort of noticing things, um, just instinctively, rather than having to make a conscious, uh, effort to try to do that."

IY also had positive feelings toward the observational aspects of their work, describing how taking field notes helped them with "paying more attention" during meetings and becoming more attuned to things like "team dynamics" and the "work approach" among other members of the

software development team. Interestingly, IY also reported that they would have performed the assigned work tasks in a similar way whether taking field notes or not. However, the field notes helped IY to better focus on what was happening around them. IY underscored this point by stating: "I was paying more attention to what we were saying [and] trying to figure out some component of our day-to-day work." To IY, the idea of technical work still centered on the particular tasks that needed to be completed, including coding, debugging, and testing. But the observational dimension and field notes changed how they approached this work, such as when they revisited their field notes to better understand the items they were responsible for.

However, these kinds of positive sentiments were not shared with IZ, who did not feel like they gained much of relevance after learning and practicing observational tasks. In fact, they continued to view the ethnographic fieldwork as "excessively subjective" and "rife with potential for misunderstanding." They much preferred interviews, where they could access participant opinions and perspectives and "get their opinions, kind of directly, more directly." On a related note, IZ was frustrated by not having a better sense of the goal of the data collection effort, especially when individuals from the company asked about their role and the nature of the research study. However, they reported that it was helpful to eventually realize, based on conversations with the project consultant and their supervising PI, that one "concrete goal" for the research was "trying to maybe steer engineering education into a more helpful direction."

Variations in observational foci and agency

The interviews, as well as the field data, also reveal variations in the observational foci and preferences among the three students. This theme was particularly pronounced for IZ, who described how their initial experience shadowing an upper manager in UtilityCo "was like my own personal nightmare." As IZ went on to describe, "I hate corporate nonsense and management. [disgusted sound] It was terrible. Suffering. Um, nice people, though. Just the daily minutiae was awful." In response, IZ spoke with both the upper manager and project PI about shifting their focus away from management and toward "what the engineers are doing." IZ further described how they "got a little bit of a longer leash" and "started kind of making my own connections, and, um, essentially, deciding for myself, like, what meetings I wanted to sit in and what I wanted to learn about and so it got a little more interesting to me personally." The additional latitude sought by IZ in turn led to interviews where they could "flesh [the details] out a little bit more than just snippets that I pick up on from overhearing conversations." As IZ further explained, these interviews were perceived as more valuable because "I have kind of a moral objection to the idea of conclusions being drawn based off of witnessing something." For IZ, the interviews grounded the fieldwork. As a more specific example of such an interview, they described "one particular construction site coordinator who I just, I had so much fun talking with, he was such a great guy [and] [i]t was nice to have a chance to kind of hear from them one-on-one and, and get their opinions on things." To IZ, the agency to choose who and where to observe – and interview – was much more appealing than shadowing the upper-level manager.

Differences in observational foci were also reflected in the data collected by – and the interviews that we later conducted with – IX and IY. For example, in their field notes IX tended to more often reflect on relationships and interpersonal dynamics, with particular emphasis on their interactions with the lead software developer. And when IX was asked in his debrief interview

about the culture of the company and its approach to software development, they quickly returned to similar themes, including by describing their work with the lead developer as "informal and more along casual lines. Um, I mean, by the end of it, I think we were both pretty comfortable." The reflections in IY's field notes, on the other hand, more often focused on their experiences with assigned technical work, including comments on their own expertise (or lack thereof), frustrations with specific tasks, how they used various supporting resources, and comments about their own learning processes and strategies. And when asked about the culture of the company in their debrief interview, they more often spoke in general terms about the organization (e.g., "it seemed like they were using Jira", "their workstyle, it seemed like it was like more, more on the casual side", "it has a very friendly environment", etc.).

Discussion

In the background section above we noted a wide variety of challenges associated with our research, from gaining access to field sites and securing IRB approvals to managing multi-modal data sets to demonstrating benefits for host organizations. Yet in alignment with the narrower focus of the findings and evidence presented above, here we mainly discuss what we learned about having students collect field data in a variety of workplace settings. Some of the specific challenges we encountered were more practical in nature. For example, IX and IY often found it difficult to complete field notes in a timely manner. These two interns sometimes felt a strong obligation to work on high-priority technical problems, which often involved learning new skills and tools, all while more generally balancing their part-time work as participant observers with other life commitments (school, family, etc.). And in situations where the interns got behind on their field notes, there is a greater risk that memories might dim and important details are left out. Indeed, over longer periods we suspect that some of their strongest memories were about the technical work and learning they experienced rather than broader and more abstract themes (e.g., social and cultural dynamics) likely of interest to our team. For IZ, on the other hand, collecting field data was a primary responsibility and they thus tended to keep a more current set of notes.

The contrasting roles occupied by IX and IY versus IZ also meant different observational dynamics and relationships within the host organizations. IX and IY were fully embedded in the start-up, giving them direct and often unrestricted access to the people, systems, source code, and tools that were the main focus of the larger research study. The host organization primarily saw them as *participants* who were fully integrated with the software development team, while their role as *observers* tended to be much less pronounced and visible to SoftCo employees and contractors. On a related note, IX and IY saw additional value in their internships as directly relevant to their disciplinary training and career goals, particularly in terms of learning technical skills, methods, tools, etc. By contrast, IZ did not participate in the work environment and only had an *observer* role, which limited their scope of access and inflected how they were perceived in various interactions with UtilityCo affiliates. Indeed, it is notable that IZ was the only student who commented on difficulties explaining to informants the nature of their role and objectives.

Another challenge in our data collection efforts involved training students to collect qualitative, ethnographic data. All of the students struggled in various ways with our relatively open data collection goals, even though we scoped the effort as a "focused ethnography" of engineering practice in specific organizational settings. Each student, in their own way, narrowed their

observations to particular topics and areas of interest. But a bigger difficulty is arguably methodological, namely in terms of some students – and especially those in STEM fields – potentially perceiving qualitative research as being overly subjective. We hypothesize that this skepticism may especially intersect with other variables, including students' prior training and personality characteristics. For example, it is notable that both IX and IY had prior exposure to social science research approaches, IX through an undergraduate degree in the field of communications, and IY through earlier experiences studying how users interact with software interfaces and visualizations. Both seemed able to adopt reasonably neutral observing stances, or at least bracket their interpretive and speculative reflections from more factual/descriptive observations (e.g., see Figure 1). We also found it helpful in our regular check-in meetings to remind students about the importance of reflecting on a wider range of observational themes.

IZ held a prior degree in English, suggesting they might be open to interpretive research methods. Yet as we note above, IZ's fieldwork experiences did little to enhance their view of ethnographic methods – and they noted that the placement was primarily useful and relevant in other kinds of ways linked to their career aspirations. Indeed, it would be safe to say that IZ expressed considerable skepticism about the value of an ethnographic approach. And given this student's personality, age, and prior experiences, they also tended to be direct and opinionated in their interactions with us – and to some extent informants as well. We infer that IZ had difficulty adopting the more detached and neutral type of observational stance often associated with ethnographic studies, potentially inflecting or even biasing their field notes and interviews. For example, it is notable how they viewed the activities of technical managers as mostly about management and not much about engineering – perhaps in part due to their dislike of bureaucracy. And as noted above, IZ seemed to evaluate the quality of interviews mainly in terms of whether they enjoyed the conversation and had a personally favorable view of the interviewee rather than considering whether the data was meaningful in relation to broader research goals. IZ's pivot toward pursuing a degree and career in engineering is also likely reflected in how they approached their role. As IZ observed, "I don't know how I didn't figure out that I wanted to be an engineer sooner in life, because I, I don't, like, I like having a goal and knowing what's going on." Such comments reflect the dominant image of an engineer "as [a] rational, no nonsense, object-world, problem solver" [27, p. 9]. Yet *not* having a goal and *not* knowing what is going on are often viewed as stances to embrace as an ethnographic observer.

Conclusion

In this paper, we discuss how three students experienced their involvement in a project that utilized ethnographic methods to investigate technical work practices in two different organizations. In other streams of work, we are continuing to process and analyze the large volumes of data collected by these students and our larger team. As the preceding account suggests, researchers considering the use of similar methods should carefully weigh the merits and drawbacks of different fieldwork roles, ranging from purely observational to full participant observation. Further, we observe the critical importance of recruiting student researchers with a keen awareness of their prior education and background, personality characteristics, and initial perceptions of qualitative research. Our results additionally underscore the importance – and perhaps limitations – of initial training and ongoing mentoring efforts meant to deepen the participating students' understanding and appreciation of ethnographic research methods. Taking

an even broader view, Chan asserts that reflection is a "must-have feature in experiential learning" [28, p. 160]. We thus see considerable potential for deepening the reflective capacities of students and professionals by teaching them observational tools and methods, both to support their own learning and generate new data and insights that can help illuminate the nature of technical work and professional learning processes in a wide variety of settings and fields.

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Appendix: Overview of Ethnographic Field Work Tutorial

Section	Topics	Activities
0. Pre-Work	Reading on Taking Field Notes	Read chapter on taking field notes in *Field Notes* text [26, Ch. 4]
1. Introduction & Overview	Introductions	• Introductions of Researcher and Observers • Overview of tutorial
2. Interactive Presentation and Discussion	Ethnographic Field Work of Engineering Practice	
2.1 Modelling work practices	Ways of looking at work • Practices • Context • Mediating elements of practice (Activity Theory)	Discuss the range of practices and variety of contextual influences on practices
2.2 Observing and recording what is going on	Various kinds of observations • Person-oriented • Activity-oriented • Material-oriented • Context-oriented • Other	Discussion
2.3 Preparation for going into field	• The objective: to document engineering practices • Note prior expectations • Plan for note-taking • Move between multiple viewpoints: Broader views to more detailed foci • Develop comprehensive observations (as much as possible) • Balance between observation and participation	Discussion
2.4 Taking notes	• Preparation (template) • Writing (using cues, “short-hand”, “head-notes” • Elaborate field notes into fuller notes and questions • Reflect on notes and what was missed • Repeat	Discussion
2.5 Summary	• Importance of writing: Making sense • Importance of practice • Withholding judgment • Checking yourself	• Discussion • Show examples of field notes

	• Protecting sources • Examples of field notes	
2.6 Practice exercise	Watch video (YouTube video of engineers at work)	• Watch video of engineers at work and take field notes of what you see • Group discussion of observations noted
3. Practice: Field Observations	• Observations in the field • Group discussion of experiences	• Read chapter on observing in *Field Notes* text [26, Ch. 5] • Choose a busy site (restaurant, school lounge, etc) • Take field notes of what you see, hear, sense, etc.
4. Field Work	• Enter field site • Note observations and upload	• Ongoing work as participant observer • Weekly meetings to discuss and elaborate notes

Sample Templates for Field Notes

Observer: (name or initials)	**Setting(s):** (list and briefly describe)	**Date(s):** (mm/dd/yy)
Field Notes:	**Reflections/Other:**	

Observer: (name or initials)	**Setting(s):** (list and briefly describe)	**Date(s):** (mm/dd/yy)

Description of Activity	**Reflections**	**Emerging Questions/Analyses**	**Future Actions**