A Review of Digital Ethnographic Methods with Implications for Engineering Education Research

Cory Brozina
Rayen School of Engineering
Youngstown State University
Youngstown, USA
0000-0001-7461-8282

Aditya Johri
College of Engineering and
Computing
George Mason University
Fairfax, USA
johri@gmu.edu

Brent Jesiek
Engineering Education
Purdue University
West Lafayette, USA
bjesiek@purdue.edu

Russ Korte
Human and Organizational
Learning
George Washington University
Washington, D.C., USA
rkorte@email.gwu.edu

Abstract— **Full Paper: Digital transformations are reshaping engineering practices with implications for conducting engineering education research. Given the paucity of discussion of digital methods within engineering education research, we believe it is important to examine and present to the community an overview of how digital technology is changing research practices. In this paper we focus on digital ethnography as it has implications for studies of technical education and work, which necessarily involve using, and observing how others employ digital data sources, tools, systems, methods, etc. In this paper we report preliminary results from an in-depth literature search and review. To select the papers for the review, we first examined prior meta-review papers that identified new ethnographic methods appropriate for digital contexts (e.g., network ethnography, trace ethnography, rapid ethnography, connective ethnography, focused ethnography, etc.). We then used these as keywords to search for papers that were representative of these methods and selected the 100 most cited papers from this corpus, with further screening resulting in a final collection of 91 papers. We then conducted free/open coding of the articles followed by thematic coding to identify six categories and dived deeper into one of the categories, focused on different approaches to ethnography, to further explore the various types of ethnographic methods mentioned in the collected literature. We close by discussing how emerging techniques in ethnographic field research can be applied to engineering education research with engineering work practices as an exemplar.**

Keywords—ethnography, digital methods, research methods, engineering profession, work practices

I. INTRODUCTION

In recent years, as engineering education has matured as a research community, increasing attention is being given to methods that are popular or emerging in the field and how novel methodologies and research practices can generate new insights. For the most part, the discussion of research methods within the community has largely been along the traditional methodological divide within the social sciences – quantitative and qualitative approaches, with a healthy dose of mixed-methods research thrown in. Increasingly, scholars in the field argue for broadening the use of methods by incorporating new forms of data collection as well as conducting research informed by interpretive methods such as autoethnography, phenomenography, and even action research methods that integrate the participants more centrally in research. Similarly, there are also advances in the use of quantitative methods especially those driven by digital data and new machine learning techniques such as natural language processing (NLP) among others. These analytics and data mining techniques are especially pertinent to large datasets that are now becoming more common.

Although fundamental advances in research methods are rare, there are aspects of research practices that are dynamic and keep evolving with changes in society more generally, including more specifically in relation to different sites of research and tools for conducting research. For instance, in the natural sciences one of the ways in which research progresses is through the invention of new instruments which in turn can profoundly shift what is researched and by whom. The electron microscope for instance, altered the landscape of physics once it started being more commonly used. Similarly, within the social sciences, recording of conversations led to increased use of discourse analysis and the common use of video has further changed how interaction analysis is undertaken and what we can learn from video data about teaching and learning and other practices. Such changes have also shifted the unit of analysis in terms of time; one can look at macro-level time scales as well as micro-level interactions. A small, micro-level interaction, as is usually the case in studies taking a symbolic interactionist approach, can be analyzed in-depth and lead to significant understanding of the context and probable outcomes.

The current shifts in the use of digital information technology, and computational technologies more generally, is changing the way in which engineering is practiced and taught. This is true of the engineering workplace where new tools for analysis,

manufacturing, design, and fabrication have made engineering more virtually distributed and faster paced, and engineering work is being undertaken in geographically and temporally distributed configurations. Digitalization have also had significant impacts on engineering education – including what is taught and how it is taught and learned – and these impacts have accelerated in the past year or so with changes made in response to the COVID-19 pandemic.

Not surprisingly, scholars across fields have started to respond to digitization and this includes reflecting on research practices and creating new forms of data collection, analysis, and reporting tools. This has occurred not only in the physical sciences, where digital data is at the core of any advance, e.g., in fields such as astronomy and biology, but even in the social sciences where new platforms such as social media applications have shifted where and how people participate in various activities and communities, demanding new approaches to better understand different aspects of people's behavior in these new contexts. Consequently, scholars have experimented with, applied, and tested new forms of data collection and analysis and there is now a robust literature on using digital methods in the social sciences and beyond.

Given this growth in method innovations and its potential relevance for research on engineering education and practice, in this paper we review the most prevalent recent work in digital ethnographic methods, defined broadly, and outline major areas of advances. We then dig deeper into one aspect of digital ethnography, namely the different forms it is taking on in practice, and seek out some relevant lessons and insights. Finally, we use this literature review to examine how engineering workplace studies research can be improved with digital ethnographic methods. We focus primarily on digital ethnography since ethnography is a popular methodology within engineering education and because research that is ethnographic or uses ethnographically-informed methods has been significantly impacted with the move to digital environments and systems to enable online or virtual forms of participation. One of these methods, digital ethnography, enhances typical ethnographic methods of data collection such as participant observations where you are embedded in the environment for long durations, and collects the same type of data from virtual entities.

II. METHODS & RESULTS

In this section we discuss our approach to collecting and analyzing relevant literature. Overall, our goal was to determine the state of how ethnographic methods are being used and discussed in the literature, including to identify topical/thematic coverage and trends, as well as emerging areas of interest and possible gaps. Our data corpus initially started with around 100 papers which were identified based on keyword searches and high citation counts.

To select the papers for the review, we started with prior meta-review papers that identified new ethnographic methods appropriate for digital contexts (network ethnography, trace ethnography, rapid ethnography, connective ethnography,

focused ethnography, etc.). We used these terms as keywords to conduct a search for papers that were representative of these methods and selected the 100 most cited papers from the search findings. Primarily, these articles appeared in the two major journals in the field *Journal of Contemporary Ethnography* and *Ethnography*, with significant representation also from *Anthropology and Education*, and *Ethnography and Education*.

Since our primary focus was on methodological concerns, we did not limit our literature collection to any particular subject of ethnographic research (e.g., technical work practices). We considered any paper with a high citation count that could be particularly relevant for our review of ethnographic studies through inspection of the paper title and a brief abstract review. We implored a high-level review of paper titles because it would provide us with the largest possible corpus in the shortest amount of time. We counted the paper in the corpus if it was initially thought to pertain to ethnographic methods of any magnitude. We did not inspect any papers for research output or correctness. However, some papers were removed if they did not pertain to ethnography or were an editorial type of paper, resulting in a final collection of 91 papers that are reported on and discussed here. Of the papers reviewed, none had an engineering focus or context. As a final step in our preliminary analysis, two researchers reviewed about 20% of the papers in the corpus to identify six categories covering the main foci/emphases represented in this collection of literature. Those categories are listed and briefly described in Table 1 below.

Table 1: Thematic Categories for Literature Collection

Category Description
Category 1: Computational tools for data collection and analysis
Category 2: Types of information you can obtain from digital sources—what data and towards what end?
Category 3: Different environments, sites, and contexts in which digital ethnography is conducted—e.g. conflict situations, community locations, workplaces, etc.
Category 4: Different approaches to ethnography—rapid, quick, focused, short-term, trace, connective, netnography, etc.
Category 5: Theoretical basis or perspective—how do new approaches compare to traditional ethnographic methods?
Category 6: How-to guides focused on practical ways to conduct research

After the six categories were finalized, three researchers independently reviewed each of the 91 papers. For each paper, up to three of the six categories were selected, with choice 1 being the most relevant or primary description of the paper, choice 2 as secondary, and choice 3 as the third most relevant category. Each reviewer could have anywhere from one to three categories listed for each paper. Counts for each category were then summed up for all three reviewers and aggregated, as shown in Table 2 below. The count in Table 2 is not a paper count, rather a total aggregation of the times the paper was

coded in that category across all reviewers. As an example, if all 91 papers were categorized as either Choice 1, 2, or 3 within category 4, the maximum total for this category would be 273.

The category with the highest count total was Category 4: Different approaches of ethnography (30.29%), followed closely by Category 5: Theoretical basis or perspective (30.29%). The category with the least count total was Category 1: Computational tools for data collection and analysis (3.24%).

Table 2: Total category counts for all reviewers

Categories	TOTAL		Choice 1	Choice 2	Choice 3
Category 1	17	3.28%	8	5	4
Category 2	51	9.83%	15	29	7
Category 3	78	15.03%	35	31	12
Category 4	159	30.64%	109	44	6
Category 5	118	22.74%	77	34	7
Category 6	96	18.50%	26	54	16

The next step was to determine how similarly each reviewer categorized each paper. Instead of reviewing each paper one-by-one to determine consensus, we logged instances where at least two of the three reviewers categorized the paper using the same category. For example, the paper by Hsu [1] was coded in Category 1 by all three reviewers (Choice 1, Choice 2, and Choice 3) giving it a score of 3 and thus counted towards the Category 1 total. If, however, only one of the reviewers categorized the paper within Category 1, it would not have counted towards the total for that category. Table 3, shown below, highlights the total count for each category with a total of at least two or three consensus codes.

Table 3: Counts of papers by category for papers with agreement of 2 or 3 raters

Categories	TOTAL	
Category 1	2	2.20%
Category 2	10	10.99%
Category 3	22	24.18%
Category 4	51	56.04%
Category 5	37	40.66%
Category 6	26	28.57%

Comparing Tables 2 and 3, the categories have similar percentages within reason and are also ranked in the same order from most to least prevalent. Thus, we conclude that the inter-rater reliability is acceptable for our reviewing schema. In Table 4 below, we showcase two sample papers from each category, one from a reviewer's choice 1 (labeled C1) and one of either choice 2 (C2) or choice 3 (C3) to show a wide variety of papers. The sample papers also showcase the wide array of publication venues that feature ethnography in some fashion.

Table 4: Sample papers from each category

Category	Example Papers (Choice in parentheses)

Category	Example Papers (Choice in parentheses)
1 (Tools)	[1] Hsu, W. F. (2014). Digital ethnography toward augmented empiricism: A new methodological framework. *Journal of Digital Humanities*, *3*(1), 3-1. (C1) [2] Laaksonen, S. M., Nelimarkka, M., Tuokko, M., Marttila, M., Kekkonen, A., & Villi, M. (2017). Working the fields of big data: Using big-data-augmented online ethnography to study candidate–candidate interaction at election time. *Journal of Information Technology & Politics*, *14*(2), 110-131. (C2)
2 (Data)	[3] Kavanaugh, P. R., & Maratea, R. J. (2020). Digital Ethnography in an Age of Information Warfare: Notes from the Field. *Journal of Contemporary Ethnography*, *49*(1), 3-26. (C1) [4] Caliandro, A. (2018). Digital methods for ethnography: Analytical concepts for ethnographers exploring social media environments. *Journal of Contemporary Ethnography*, *47*(5), 551-578. (C3)
3 (Sites)	[5] García-Rapp, F. (2019). Trivial and Normative? Online fieldwork within YouTube's beauty community. *Journal of Contemporary Ethnography*, *48*(5), 619-644. (C1) [6] Hammersley, M. (2006). Ethnography: problems and prospects. *Ethnography and education*, *1*(1), 3-14. (C2)
4 (Types)	[7] Bluteau, J. M. (2019). Legitimising digital anthropology through immersive cohabitation: Becoming an observing participant in a blended digital landscape. *Ethnography*, 1466138119881165. (C1) [8] Islam, G. (2015). Practitioners as theorists: Para-ethnography and the collaborative study of contemporary organizations. *Organizational Research Methods*, *18*(2), 231-251. (C3)
5 (Theory)	[9] Vom Lehn, D., & Hitzler, R. (2015). Phenomenology-based ethnography: Introduction to the special issue. *Journal of Contemporary Ethnography*, *44*(5), 539-543. (C1) [10] Walker, D. M. (2010). The location of digital ethnography. *Cosmopolitan Civil Societies: an interdisciplinary journal*, *2*(3), 23-39. (C2)
6 (How-to)	[11] Luttrell, W. (2000). "Good enough" methods for ethnographic research. *Harvard Educational Review*, *70*(4), 499-523. (C1)

[12] Safronov, P., Bochaver, A., Nisskaya, A., & Koroleva, D. (2020). Together apart: field notes as artefacts of collaborative ethnography. *Ethnography and Education*, *15*(1), 109-121. (C2)

or contexts in which ethnography is conducted (Cat 3, n=32). The types of information obtained from digital sources (Cat 2, n=22) and theoretical basis (Cat 5, overall n=26) were also discussed significantly within the Category 4 papers. Papers reporting on computational tools (Cat 1, overall n=7) were least discussed within the Category 4 subset of papers.

Table 5: Ethnography Approaches

Type of Ethnography	N	C1	C2	C3	C5	C6	Common Definition
Applied	1				1	1	Understand behaviors within a short time frame, bound in hypothesis testing and theory-driven observation, with a strong emphasis on verifiability.
Big-data-augmented	1	1	1			1	Integrating ethnography with computational data collection.
Connective	4		3	4	2	2	Blending of both 'offline' and 'online' practices and artifacts.
Design	2				1	2	Focuses on what people do, why and what is relevant for them.
Digital	11	3	8	6	5	8	Combining digital media with the elements of story to represent different cultures.
Focused	3	1		2	2	3	To focus on specific episodes or interactions in social fields.
Geo-	1			1		1	Combining geographic information system technologies with ethnographic data.
Internet	1		1	1	1		All contextual data are collected online without meeting people face-to-face.
Militant	1			1		1	Politically engaged participation in a social movement to understand social justice work and learn with other participants.
Multi-dimensional	1			1		1	Considering both a variety of experiential spaces and how those spaces are integrated into the lives of those studied.
Multimodal	1		1			1	Combining of different media sources to see meaning as emerging from that integration.
Multi-sited	1			1			Being both in and outside of the world system.
Network	3		2	2	1	3	Process of using ethnographic field methods on cases and field sites selected using social network analysis.
Online	2	1	1	1	1	1	Applies traditional methods to virtual environments.
Rapid	9	1	3	8	3	8	Collection of thick data wtihin a short timeframe and targets specific problems or priorities.
Short-term	1				1	1	Characterized by forms of intensity that lead to deep and valid ways of knowing.
Social media	1		1		1		Produces ethnographic places that traverse online/offline contexts and are collaborative, participatory, open, and public.
Trace	1				1	1	Following a detailed approach to documentation of artifacts.
Virtual	6		1	5	5	3	To understand whether and to what extent the virtual is different from the real.
Total Category Counts		7	22	32	26	38	

Given the relatively high number of papers in category 4, we took a closer look at the 51 papers in that category to further explore what different approaches were discussed. We also examined how those 51 papers were related to and aligned with the other five categories discussed above. Table 5 showcases the 19 different types of ethnography discussed within the 51 papers that were classified in category 4—different approaches to ethnography, along with a common definition across all papers.

For those papers identified as discussing an ethnography approach other than a traditional method, most of those papers discussed 'How-to conduct research' (Cat 6, n=38) using a particular ethnographic method, and the different environments

III. DISCUSSION

Our review presents preliminary findings from a review of literature on emerging ethnographic research and highlights some areas where new research opportunities might exist. More specifically, our review shows that 51 of 91 (or about 56%) of the papers discuss different approaches to ethnography, such as rapid, digital, virtual, connective, and focused. Discussion in the research literature on these new forms of ethnography is vital and important as researchers become aware of, utilize, and refine these emerging methods.

On the other hand, only 2 of 91 (or about 2%) of the papers discuss the various computational tools for data collection and

analysis. This shows that the research field is not necessarily focused on such tools. However, 26 of 91 (or 29%) of the papers were counted in Category 6, focused on how-to conduct various ethnographic research approaches. This suggests that the overall process of using these ethnographic methods are being discussed in a manner in which the methods can be implemented, but perhaps without adequate attention to computational tools and digital data. As technical work processes and products continue to be more and more digitized, there will be more of a need to use computational tools to not only collect but also analyze data.

As described above, there are many forms and hybrids of research methods emerging under the banner of ethnography. An ongoing controversy engaging the advocates and critics of these "novel ethnographies" is the claim to the label of ethnography [13]. Traditionally 'owned' and practiced by anthropologists, 'real' ethnography developed into a type of research known for its commitments to immersion in a 'strange' culture (an approved topic) by a lone ethnographer requiring a significant amount of time in the field—typically one to two years. Later, controversies occurred regarding the topic of study (e.g., local social problems, not approved), the group (organizational ethnography was suspect at first), and other variations in the method [13]. It is always dangerous to cite a single definition of a practice in science, or elsewhere, and with that precaution the work cited above derives from an eclectic view of ethnographic research methods. If a goal of ethnography can be described as providing a means to a better understanding of a group in a social context based on its culture, practices, artifacts, organization, beliefs, and values, then multiple methods would likely help us better understand the multifaceted nature of groups and their associated (sub)cultures, cultural practices, values, and beliefs, etc. The methodology of ethnography, grounded in its interpretive, constructionist stance, sometimes gets lost behind particular methods of research. The controversy seems to turn on beliefs in the importance of the sense made of the findings versus the objectivity of the findings.

All that aside, there are strong arguments above for using a variety of methods to better understand professional practice in engineering and other fields. The problems with execution of methods is distinct from the methods themselves. As Hogan [14] suggested, there is a need for more discussion of what makes useful knowledge. And judging the usefulness of knowledge is rarely helpful without having that knowledge in hand. That is the goal of this project—to examine the ways in which knowledge of the variety of engineering practices can be gathered without pre-judging either the knowledge or the methods beforehand.

IV. EXEMPLAR CASE: ENGINEERING WORK PRACTCES

Within engineering education, research on professional engineering work is a critical and continuous need given how this work is continually changing, which in turn demands additional investigation to help prepare the future workforce in light of rapidly evolving job roles and responsibilities. One of the ways in which this gap can be addressed is by new forms of data collection and analysis that facilitate the more rapid generation of new knowledge about engineering practice so that our understanding of the field keeps pace with ongoing changes. New methods of gathering and analyzing data about engineering practice can provide more relevant and timely insights into the work of engineers—and consequently enhance students' understanding of engineering work. We now briefly discuss how novel digital ethnographic methods might help with conducting research on engineering work practices.

As suggested by Table 5, it is first worth noting the prevalence of more "agile" ethnographic approaches, referred to in this body of literature using terms like applied, focused, rapid, and short-term. In contrast to more traditional ethnographic fieldwork methods that assume participant observers are fully embedded in a given setting for an extended period of time (i.e., a year or longer), these alternative strategies often recommend a tightening of scope (in terms of time and location of the researcher's observations, frequency and range of interactions between the researcher and field site, etc.) and tend to be more problem-focused and directed in their objectives. Such approaches thus have a number of possible advantages, including in terms of requiring fewer resources, appealing to funding agencies or host sites that want research to explore specific issues or address particular types of problems, and generating findings and results more rapidly. We also find it encouraging that many "how-to" guides exist in the literature for various kinds of agile ethnographic field methods.

Second, we observe that many other methods profiled in Table 5 are focused on different kinds of online interactions, communities, and other types of digital data sets. Keywords and concepts here include: big-data-augmented, digital, Internet, online, trace, and virtual ethnographies. Such approaches can help guide researchers as they collect and analyze digital data such as online chats, e-mails, system logs, and many other types of communication and interaction records. Quite simply, such records dramatically increase the researchers' observational capacity – potentially opening up new insights that can in turn help guide redirected or more targeted data collection efforts. Yet gaining access to such data (e.g., in engineering workplace settings) may raise new challenges, including negotiating issues of confidentiality, intellectual property, and related concerns with organizational gatekeepers. And once such access is secured, finding ways to archive, process, and analyze these data sets may in turn require the development and of new research tools and methods.

On another related note, a growing literature on "connective" and "multi-modal" forms of ethnography suggest a growing discussion around methods, strategies, and exemplar studies that explore how to blend and integrate traditional and digital sources of field studies data. Additionally, new forms of "network" ethnography involve combining fieldwork data with well-established social network analysis techniques. This approach has considerable potential for generating novel insights by systematically mapping out large and complex networks of social relationships – such as those associated with engineering design or capital projects in large corporate organizations.

Digital diaries or journals, viewed as a part of digital ethnography, can additionally provide longitudinal data on work practices, generating insights that are often lacking in many studies that focus on cross-sectional data collection (i.e., interviews or observations that last a few days or weeks). As a more specific example, collecting digital diaries or autoethnographies from early career engineers could provide novel perspectives on newcomer socialization, mentor-mentee relationships, workplace learning, and professional identity development, to name just a few relevant topics (e.g., see [.

As terms like "social media ethnography" suggest, digital approaches can also shed light on work practices through alternative virtual ethnographies, such as those that can be conducted in the context of various online forums. Studying sub-communities and groups on web sites like StackExchange and Reddit has considerable potential to generate empirically-grounded digital portrayals of contemporary engineering work. As yet another example, analysis of social media data, such as hashtag activism campaigns that focus on workplace diversity, can present alternative and more diversified views of the profession. One might in turn see how emerging forms of "militant" ethnography, as noted in Table 5, may involve researchers taking up activist roles while simultaneously carrying out traditional and/or online forms of fieldwork.

V. Conclusion

In this paper we report results from a review of literature on emerging ethnographic research methods. Based on analysis of 91 highly cited papers, we observe that papers discussing new approaches to ethnography (Category 4) and comparing such approaches to more traditional methods (Category 5) were particularly prominent. Papers offering how-to guides (Category 6) or perspectives on specific settings or topics of research (Category 3) were also reasonably prominent. However, there seems to be a relatively lack of attention in the literature to the various types of data collected (Category 2) and associated computational tools (Category 1). The types of digital ethnography are discussed and highlights indicate a diverse variety of ways in which non-traditional ethnographic methods are being developed and utilized. Building on this literature and our associated observations, our research team is now preparing to undertake field studies data collection at multiple sites. This will provide us with direct opportunities to test and try some of the methods and approaches outlined in the literature, with the goal of developing more timely and nuanced understandings of technical work practices in a variety of organizational settings.

References

[1] Hsu, W. F. (2014). Digital ethnography toward augmented empiricism: A new methodological framework. *Journal of Digital Humanities*, *3*(1), 3-1.

[2] Laaksonen, S. M., Nelimarkka, M., Tuokko, M., Marttila, M., Kekkonen, A., & Villi, M. (2017). Working the fields of big data: Using big-data-augmented online ethnography to study candidate–candidate interaction at election time. *Journal of Information Technology & Politics*, *14*(2), 110-131.

[3] Kavanaugh, P. R., & Maratea, R. J. (2020). Digital Ethnography in an Age of Information Warfare: Notes from the Field. *Journal of Contemporary Ethnography*, *49*(1), 3-26.

[4] Caliandro, A. (2018). Digital methods for ethnography: Analytical concepts for ethnographers exploring social media environments. *Journal of Contemporary Ethnography*, *47*(5), 551-578.

[5] García-Rapp, F. (2019). Trivial and Normative? Online fieldwork within youtube's beauty community. *Journal of Contemporary Ethnography*, *48*(5), 619-644.

[6] Hammersley, M. (2006). Ethnography: problems and prospects. *Ethnography and education*, *1*(1), 3-14.

[7] Bluteau, J. M. (2019). Legitimising digital anthropology through immersive cohabitation: Becoming an observing participant in a blended digital landscape. *Ethnography, 22*(2). doi: 1466138119881165.

[8] Islam, G. (2015). Practitioners as theorists: Para-ethnography and the collaborative study of contemporary organizations. *Organizational Research Methods*, *18*(2), 231-251.

[9] Vom Lehn, D., & Hitzler, R. (2015). Phenomenology-based ethnography: Introduction to the special issue. *Journal of Contemporary Ethnography*, *44*(5), 539-543.

[10] Walker, D. M. (2010). The location of digital ethnography. *Cosmopolitan Civil Societies: An Interdisciplinary Journal*, *2*(3), 23-39.

[11] Luttrell, W. (2000). "Good enough" methods for ethnographic research. *Harvard Educational Review*, *70*(4), 499-523.

[12] Safronov, P., Bochaver, A., Nisskaya, A., & Koroleva, D. (2020). Together apart: field notes as artefacts of collaborative ethnography. *Ethnography and Education*, *15*(1), 109-121.

[13] Agar, M. (2006). An Ethnography By Any Other Name. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, 7(4).

[14] Hogan, A. (2016). Network ethnography and the cyberflâneur: Evolving policy sociology in education. *International Journal of Qualitative Studies in Education, 29*(3), 381-398.

[15] Lutz, B., & Paretti, M. (2021). Exploring the social and cultural dimensions of learning for recent engineering graduates during the school-to-work transition. *Engineering Studies, 13*(2).