How Do You Tell a Story About Epistemic Injustice?: Pilot Testing for a Three-Interview Structure

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Abstract

The purpose of this full research paper is to describe the piloting of a three-interview protocol to explore epistemic (in)justice (EIJ) within undergraduate engineering women's academic experiences using narrative analysis.

Women's underrepresentation in engineering is well-documented, and numerous efforts have fought to increase women's presence in engineering spaces. However, women continue to participate in engineering as a minority despite policies supporting their inclusion. To explore women's limited inclusion in engineering, engineering education research (EER) has looked to epistemology and other epistemic theories. Researchers have looked into the epistemic dimensions of engineering education to understand the cultural foundations that undermine policies and practices that support diversity, equity, inclusion, and justice. One such theory researchers utilized explored justice in epistemic interactions, aptly named epistemic injustice. We employ epistemic injustice to explore undergraduate women engineering students' stories and produce contextually specific epistemic snapshots of the experiences of women in engineering. Women's stories of epistemic injustice based on their engineering experiences will highlight possible misalignments between inclusive policies for women and their realities of being part of a minority population in engineering. However, accessing stories of epistemic injustice can be difficult due to the complexity of the theory; as such, intentional processes for generating data collection tools must be developed and documented.

This paper details the piloting phase of an interview protocol for narrative analysis for a larger research study. We elaborate on the stages of instrument development, including method justification, building a preliminary interview protocol, peer review, piloting, and refinement. First, we justify methods by explaining the alignment between narrative analysis and the three narrative interview structure. Then to build a preliminary interview protocol, we connect the basic outline of the protocol to theoretical framing, showing how each question measures a particular form of epistemic injustice. During the peer review phase, we detail the contributions of multiple research groups in refining word choice, question types, and question order in the preliminary interview protocols, establishing quality in the instrument. Lastly, we go through the piloting and refinement process, in which we illustrate how we used the lessons learned from each pilot to make changes to the interviews, both in protocol composition and interviewer style.

Results from the piloting phase include an effective instrument for data collection that captures women undergraduate students' experiences of EIJ and their conceptualizations of personal epistemology. The impact of the piloting phase on the larger study includes instrument refinement and skill development to collect rich data through effective narrative interviewing techniques. Future work will leverage this instrument to generate narratives of epistemic injustice and educate engineers on how injustice manifests and can be countered to foster better experiences for women.

Introduction

Women are underrepresented in engineering [1], [2]. Women's underrepresentation perpetuates the male domination of the engineering field and the subsequent oppression hegemony inflicts [3], including stereotypes against women [4], [5] and gender identity prejudices that overemphasize and undervalue women's contributions [6]. Engineering education research (EER) has explored possible explanations as to why this phenomenon persists despite sustained efforts to recruit and retain more women in engineering [7]. One explanation of women's underrepresentation is the ways knowledge and knowing are produced, evaluated, understood, and valued that are foundational to engineering education and their potential to disenfranchise women [8]. This paper is part of a larger study where we explore the epistemological foundations of engineering alongside women's epistemologies and how different ideas about knowledge and knowing relate to women's underrepresentation in engineering.

Our exploration of the interaction between engineering and women's epistemologies utilizes the theory of epistemic injustice, or the wrongdoing done to someone based on the perception of their capabilities as a knower [9]. While epistemology has been discussed in engineering education [10]–[14], this research has not utilized epistemic injustice in engineering contexts. Epistemic injustice is operationalized through testimonial and hermeneutical injustice, sub-theories of epistemic injustice, to show how engineering culture facilitates unearned privilege for some while simultaneously disadvantaging and possibly harming others.

In the larger study, we aimed to capture the experiences of women undergraduate engineering students, particularly related to epistemic (in)justice (EIJ), through their narrative stories. EIJ, while present in women's experiences, is difficult to measure because of theoretical density. This difficulty can make the articulation of stories around the theory get lost or lack proper attribution to the larger problem. Thus, additional prompting and guidance is needed in measurement tools. Additionally, the processes for collecting student stories through narrative analysis, outlined in the literature, assume students can openly talk about their stories with minimal prompting. Given the contrasting goals that emerge from trying to understand women's experiences with EIJ and gathering their stories, this work explicitly explores how we navigated the processes of qualitative protocol development and implementation that leverages the strengths of each while attempting to minimize weaknesses.

We developed an interview protocol consistent with the methods of narrative analysis and the three-interview data collection approach [15], [16]. We used a three-interview data collection protocol to build rapport, capture participants' epistemic experiences, and facilitate reflection of the impact of those experiences on their personal epistemology, respectively with each interview. As this protocol has not been tested in EER, we conducted a piloting phase to ensure the quality of the data collection instrument [17], [18]. This paper offers a potential procedure for piloting three interviews for narrative analysis, even though piloting studies are rare for narrative analysis methods [19].

The piloting procedure tested an interview protocol to explore EIJ within undergraduate engineering women's academic experiences using narrative analysis. In the Fall of 2024, we went through the piloting phase to refine the three interview protocols. In this paper, we operationalize the theoretical framework of epistemic injustice to outline what we sought to measure. Then, we summarize the data collection and analysis methods for the study and how we planned to pilot based on those restrictions. Once piloting methodology is established, we detail

the five stages of the piloting process: methods justification, building a preliminary interview protocol, peer review, piloting, and refinement. Lastly, we discuss the results of the piloting phase, including lessons learned that impact the data collection and preliminary analysis phases of the research.

Positionality

The context of white supremacy and patriarchy in engineering impacts each of the authors of this paper in unique, nuanced ways due to how the systems of power and oppression interact with our intersectional identities. To provide transparency in how we approach these concepts and to add context to this work, we have provided positionality statements for each author on the research team [20].

Kaitlyn Thomas: I am a heterosexual, white woman raised by two working-class parents in a double-income household. I graduated from a private, teaching-focused university in Texas with bachelor's and master's degrees in civil engineering with an emphasis on structural engineering. I also worked for three years as a structural engineer before going back to school and pursuing engineering education. Because of the privilege I experience as a white person and the sheltering of experiences that my privilege offers, I have undergone a massive amount of learning to identify systems of oppression embedded in the culture that may limit others in the profession. My goal with my research is to explore norms in engineering to understand and identify systems of oppression embedded in the culture that may limit marginalized communities in the profession.

Adam Kirn, PhD: I am a gay, white, able-bodied, cisgender man with tenure in Engineering Education. My work centers how we create change in engineering environments to foster equity and inclusion. My research focuses on engineering graduate and undergraduate students' experiences to generate data-driven targets for change. I also served as the co-chair of my College's Diversity, Equity, and Inclusion committee. This committee is actively working to change faculty practices, as such this paper represents action motivated by local need for implementation.

Kelly Cross, PhD: I am a Black, female, same-sex loving engineering professor with strong beliefs around spirituality. I am a first-generation PhD in my family and was raised in a racially and economically segregated large city in the Midwest. My research agenda is to broaden participation in engineering. My previous research investigated the experiences of multiple marginalized groups including women of color and members of the LGBTQ spectrum. I typically take an intersectional approach to identity in research and I am passionate about giving voice to those often overlooked in the business of educating engineers in the U.S.

Theory

Theoretical Framework: Epistemic Injustice

We introduce epistemic injustice as the theoretical framework on which the pilot study's interview questions are based. Epistemic injustice is defined as the phenomenon in which an individual receives unjust treatment based on negative perceptions of their capabilities as a knower [9] (Table 1). Epistemic injustice is helpful in the context of engineering learning environments because it considers power and privilege within social dynamics that reveal the subtle forces that aim to undermine or undervalue women.

The theory takes a sociological perspective by viewing participants acting as pieces of a social sphere with different relationships of power between each other. This social power pattern allows for certain knowledge to be valued over others, which is the crux of the theory of epistemic injustice. Furthermore, social power can be broken down into a subtype of power called "identity power" (p. 4), defined as social power that depends on a group's shared understanding of social identities affected by the operation of power [9]. Identity power further delineates certain knowledge as valuable based on the identities of those who share them. For example, the context of white supremacy and patriarchy that form the foundation of engineering culture dictates that white men share the greatest identity power, so their knowledge is most valued and shared within engineering spaces.

Under the theory of epistemic injustice, we define two sub-theories that were the foundation of the data collection protocol: testimonial and hermeneutical injustice. Testimonial injustice is a type of epistemic injustice in which a "prejudice causes a hearer to give a deflated level of credibility to a speaker's word" [9, p. 1] (Table 1). Testimonial injustice takes place between two individuals—the hearer receiving information and the speaker giving information—within a testimonial or informational exchange. For a productive testimonial exchange to take place, the hearer must make a credibility judgment, in which they believe some level of truth and trustworthiness from the speaker to determine the information as true and valuable [21]–[23]. The hearer can make this credibility judgment based on the speaker's characteristics or identities, how the speaker conveys the information, prior knowledge, and the structural qualities of the message [21]. Each of these sources offers opportunities for implicit biases, or unconscious ingrained thought patterns, prejudices, or stereotypes to be used in credibility judgments [24]. If the hearer judges the speaker as having more or less credibility than what the speaker legitimately has, the hearer commits an epistemic injustice to the speaker by incorrectly judging their credibility in the context of the testimonial exchange. Testimonial injustice takes place within an exchange of information, in which identity power dictates the dynamics of credibility in the conversation.

As testimonial injustice examines identity power between individuals, hermeneutical injustice accounts for the identity power dynamics inherent in the social systems guiding cultures. Hermeneutical injustice is a systemic gap in resources that unfairly disadvantages a group in making sense or meaning of their own personal experiences [9], [21] (Table 1). For example, engineering holds onto the epistemological belief of meritocracy [25], in which achievement in the field is earned through merit or technical engineering abilities. Research has shown that meritocracy is a false epistemology in engineering culture that continues to promote divisiveness and privilege [26]–[29]. As a result, those with social connections or who carry identities that offer them privilege often achieve more in engineering than those who do not. Therefore, students lacking social connections or privilege may believe the lack of progression in their career or education is due to intellectual failures when in reality, the myth of meritocracy hides the biases and prejudices of the hegemonic majority that lurk underneath its façade [3].

Since hermeneutical injustice is systemic in nature, the disparities in privilege and advancement as determined by the identity power dynamics prevalent in the culture form the context for social interactions that can manifest testimonial injustice. For example, when situating research within engineering learning environments, the disparities that stem from white supremacy, patriarchy, and colonization are present. The privilege formed from these and other systemic ideologies define the dynamics of social power in instances of testimonial injustice. Therefore, although

testimonial and hermeneutical injustice are analytically distinct, they interact and influence each other because neither of them can be separated from the cultural context in which they are situated. The research design utilized both testimonial and hermeneutical injustice as sub-theories to operationalize in the interview protocol, as both forms are distinct but intertwined.

Theoretical Backing: Personal Epistemology

To understand the epistemological impact of EIJ may have in engineering contexts, we introduce the theory of personal epistemology. Personal epistemology is a set of beliefs about knowledge and knowing that can shape an individual's understanding of themselves and others [10], [30], [31] (Table 1). Belief categories include the definition of knowledge, the construction of knowledge, evaluation of knowledge, where knowledge resides, and how knowing occurs [30]. To help understand the theory of personal epistemology used for the larger study, we constructed a theoretical framework to categorize knowledge beliefs based on the definition of epistemology [30]. The categories of knowledge beliefs were used during the pilot interviews, and they helped the participants reflect on their stories of EIJ and how they affected their beliefs about knowledge or learning in engineering.

Table 1: List of Theoretical Definitions and Engineering Context Examples

Construct	**Definition**	**Engineering Context Example**
Epistemic (In)justice (EIJ)	Epistemic injustice: the phenomenon in which an individual receives unjust treatment based on negative perceptions of their capabilities as a knower [9]. Epistemic justice: the opposite phenomenon in which an individual receives just treatment for their knowledge contribution.	Epistemic injustice: see examples for testimonial and hermeneutical injustice. Epistemic justice: being taken seriously in a technical conversation; others not needing a second opinion when information is offered.
Testimonial Injustice	A type of epistemic injustice in which an individual in an exchange of information is seen as having more or less credibility than what is true [9].	Being undermined, ignored, belittled, or talked over in a conversation
Hermeneutical Injustice	A type of epistemic injustice in which an individual does not have the knowledge resources available to make sense of themselves or their reality [9].	Intentionally being told in a class to work unnecessarily hard because of antiquated traditions (i.e. "*I learned the hard way, so you have to too*.")
Personal Epistemology	A set of beliefs about knowledge and knowing that can shape an individual's understanding of themselves and others [10], [30], [31].	"Knowledge is technical in nature;" "knowledge comes from experts or professors;" "I know I learned something if I get a good test grade."

Guiding Research Questions

Guided by the goals of our larger study—capturing women's stories of EIJ in engineering—we sought to develop an interview protocol that created alignment between the rich theoretical traditions of epistemic injustice and methodological traditions of narrative analysis [15], [32]–[34]. By engaging in a data collection and analysis process guided by these traditions, we can generate rich narratives that expose the insidious ways epistemic injustice undermines women's experiences and retention in engineering. To that end, this paper explicitly articulates our process for piloting and refining an interview protocol to address this area of need.

To guide the protocol development, we utilized research questions from the larger project: 1) How do women engineering students describe their experiences of epistemic (in)justice? and 2) How do women engineering students interpret the impact of epistemic (in)justice on their own personal epistemologies in the context of or regarding the engineering field? To answer the research questions (RQs), we used a three-interview data collection structure [16], [35], [36]. To understand the requirements for the interview protocol, we review the methodological and data collection choices for the larger study as the background needed for the piloting phase. Then we discuss the piloting methodology, including alterations based on time and resource restrictions and study-specific needs to refine and solidify the data collection protocol.

Background: Methodology and Data Collection Method for the Larger Research Study

Narrative Analysis Methodology

We employed narrative-type narrative inquiry (narrative analysis) to construct participants' epistemic stories [15]. Narrative analysis uses the action of storytelling for the participants to make meaning from their experiences. The RQs center the voices of women engineering student participants through their descriptions (RQ1) and their interpretations (RQ2) of EIJ. Narrative analysis is appropriate in this case because the outcome produced will be the stories told from the participants' points of view regarding EIJ and their personal epistemologies [15].

As these stories were meant to be from the participants' perspectives, a foundational understanding of EIJ and personal epistemology were required, even to simply identify the experiences in their engineering educations that were relevant to their narratives. To acquire the foundational knowledge needed to perform the study, the participants needed to collaborate with the researcher to form their own understanding of the theoretical frameworks in the study. To ensure collaboration between the researcher and participants, a three-interview data collection method was employed [16], [35], [36]. Each interview provided the interviewer and participants an opportunity to gather data for narrative analysis and understand EIJ, personal epistemology, and the significance of their narratives in engineering education research.

Three-Interview Method

The three interviews in the data collection plan were semi-structured interviews [16], [37] approximately 30-90 minutes in length. The interviews supported monologues from the participants with occasional interruptions from the interviewer, including clarifying or redirecting questions.

The first interview built rapport between the interviewer and participant and formed the framework for each participant's narratives. Questions were asked to explore the specific context of the participant's engineering education experiences, which helped situate subsequent interview questions in the participant's unique contexts. To capture epistemic experiences

without using difficult terminology from the study's theoretical framework, broad examples of EIJ were used, like experiences of understanding (or not) concepts taught, feeling encouraged or discouraged in learning, feeling like one's knowledge was (or was not) heard or understood, or having one's knowledge treated unfairly. For specific wording, see Appendix A, which offers the full list of main interview questions, excluding the greater interview protocol prompting the beginning consent statement and ending question-and-answer with the participant. The first interview also established a baseline understanding between participant and interviewer regarding the definition of EIJ and personal epistemology, examples of each, and ideas of how they may manifest in their own experiences. This involved a question-and-answer time for participants to ask about the research, including its motivation, the significance of their narratives, or details regarding the theory of EIJ or personal epistemology. This step involved the co-construction of knowledge between the lead researcher and participant because the participant used the researcher's understanding of EIJ to choose the experiences they wanted to tell, which included the researcher's own epistemologies. This was a limitation of the study and could affect how participants interpreted their own experiences.

The second interview established large plot points and details in participants' narratives. The interview began with a round of member checking so participants could see the basic outline of their narratives constructed by the researcher. Then the interviewer asked for details on the instances situated in each of the participant's unique engineering education experiences. The interviewer inquired about events that preceded or followed the experience, how the experience made the participants feel, downstream consequences of the event, or takeaways from the experience. See Appendix A for specific questioning. The interview ended with another opportunity for question-and-answer dialogue between the participant and researcher to clarify details about the research design or clear up confusion about EIJ and personal epistemology.

The third interview built out the narratives and connected each participant's personal epistemology to their stories of EIJ. Similar to interview two, the interview began with a round of member checking for the participants to check their narratives in progress constructed by the researchers. Then the interviewer asked how their stories of EIJ affected their learning or knowledge beliefs, which formed their personal epistemology.

Limitations

Limitations to the piloting phase concentrate in the interview one protocol that asked about participants' experiences of EIJ. As mentioned previously, the co-construction of knowledge required between the researcher and participant to build an understanding of EIJ presents a limitation in the ways the participants interpreted the theory and chose the experiences to include in the interview. Also, the specificity of context that was provided when asking about instances of EIJ could potentially limit how the participants answered. When asked about whether participants experienced certain instances (e.g., being ignored, undermined, or intentionally misunderstood), the interviewer offered particular contexts in which those events could take place (i.e. in class, in teams, in study groups, internships, research, co-ops, conversations, etc.). This list was added because pilot participants often were confused about the events the interviewer was inquiring about. Though these contexts were meant to widen the participants' ideas about their experiences, the list of contexts could serve to limit them as well. Also, the limited contexts could produce leading questions in the protocol. The pilot showed that these details the protocol were beneficial, but they could produce limitations in the study.

Piloting Process: Five Stages

The piloting process contained five main stages of development: methods justification, building a preliminary interview protocol, peer review, piloting, and refinement. After the five stages, the data collection phase of the larger study was strengthened in protocol quality and time efficiency.

Methods Justification

First, we address the alignment between narrative analysis and three interviews. As expected, we faced difficulties with participant meaning making of EIJ because the term was unfamiliar to them, and most had not thought about their experiences using EIJ. The reason for choosing narrative inquiry as the methodology was because of its strength in telling stories from the participants' perspectives. Using narrative analysis required meaning making to come from participants during the interviews, not from the researcher analyzing the data. This was why three interviews were necessary: the extended time between participant and interviewer and the time between interviews allowed space for meaning making, member checking, and reflection from the participants. We recognized that we were asking a lot of the participants. The chosen research methods allowed participants the space to convey their stories meaningfully in a way that was comprehensible not only to the researcher but to them as well. Though three interviews helped facilitate the time for participants to recognize EIJ in their engineering educations and make meaning from those experiences, tensions still existed in allowing the participants to interpret EIJ through their unique perspectives while keeping the interviews focused on collecting data to answer the RQs. Researcher expertise was needed to keep the interviews on the right track, but participant voices were the main output of the interview process. We navigated the tension of researcher participation and knowledge co-construction when building the interview protocol.

Building a Preliminary Interview Protocol

Once methodological alignment was established, we connected the basic outline of the interview protocol to theoretical backing, showing how each question measured a particular form of EIJ. While crafting the interview protocol, we recognized that all events or experiences involving conversation or interaction with others had an epistemic dimension, though not all were examples of EIJ. Due to this ubiquitous trait amongst all social phenomena, the line of interrogation in the interviews had to be specific enough to capture the epistemic nature of the events, but the questions had to be understandable to the participants who had never engaged with epistemic research. We intentionally excluded epistemic language from the interview questions and included language that was more commonly understood by non-researchers. For example, we used keywords to elaborate on examples of EIJ, such as being "undermined," "ignored," or "intentionally misunderstood," which were all indications that their credibility was not properly acknowledged.

In the first interview, we asked questions that aimed to create a timeline of epistemic experiences for the participants in engineering. We reference questions from the piloting interview protocol, listed in Table 2 in Appendix A. These questions are not reproduced here due to space limitations. Questions 1-01 to 1-06 asked about background information to contextualize the participants' experiences, such as their majors and preliminary ideas about engineering knowledge. Questions 1-07 to 1-10 asked about potential instances of hermeneutical injustice. Participants had the opportunity to talk about the culture of a classroom or teaching norms that may have influenced how they learned or interacted with the knowledge. These prompts may

have led to instances of hermeneutical injustice, in which the culture of engineering played a role in the unjust treatment of the participants' knowledge. Questions 1-11 to 1-14 asked about potential instances of testimonial injustice. Question 1-11 referred to an example of credibility excess, in which one received too much credibility, and they did not have the intellectual resources or knowledge to finish the tasks given to them. Question 1-12 referred to an example of epistemic justice, in which one's knowledge was acknowledged and valued in an interaction. Question 1-13 referred to an example of credibility deficit, in which one was not given their deserved credibility, and their knowledge was treated unfairly. Lastly, question 1-14 inquired about the participant witnessing EIJ being done to someone else. Participant feedback during the pilot and refinement phases indicated the need to add this last question.

The contexts of the questions inquiring about EIJ (both testimonial and hermeneutical) were left intentionally broad to prompt a wide array of responses. Later in data analysis, the lead researcher would decide whether the experiences that came up were examples of EIJ. The list of questions in interview one began with general questioning, then led to inquiries about hermeneutical injustice (when the culture served to treat the participants' knowledge unfairly, like when the participant struggles unnecessarily due to lack of knowledge resources in the class), and finally ended with inquiries about testimonial injustice (when individuals treated the participants' knowledge unfairly, like ignoring, undermining, or talking over the participant), all of which were used to establish the participants' background information to construct the subsequent interviews.

The second and third interviews let the participant tell a story and speak freely about the moments listed in their timeline from interview one. As a result, the line of questioning was more redundant and iterative, and significant portions of the protocol required personalization for each participant. Questions about gender could be personalized to their specific experiences, and the questions asking about personal epistemology needed to be shaped in context with their narrative responses from previous interviews. The time between the first and second interviews (approximately two weeks to one month) was designed to allow the researchers to personalize the participants' interviews to interrogate their specific experiences on their timelines. While unique for each participant. With the understanding that the protocols were different for each participant, we developed a basic line of questioning for interviews two and three. Interview two (questions 2-01 to 2-09) aimed to build out the participants' temporal narratives, chronicling the sequence of events in their epistemic history. Interview three (questions 3-01 to 3-03) aimed to show the evolution or development of their personal epistemologies parallel to the epistemic events told in their narratives. To support the quality of the preliminary interview protocol, we sought peer review from the EER community.

Peer Review

During the internal testing and expert assessment phase [18], we called upon the expertise from multiple engineering education research groups and mentors in the field to help refine word choice, question types, and question order in the preliminary interview protocols. Before we began piloting, we enlisted the help of the [*Redacted*] research groups to verify that the protocols were measuring what we wanted them to measure. We also sought out the expertise of [*Redacted*], who are experts in narrative inquiry in engineering education research. [*Redacted]* offered helpful citations and interviewing tips that made the interviewer more comfortable and increased their confidence in interviewing during the pilots. After receiving the advice from mentors and colleagues, we were ready to start field testing the interviews [18].

Piloting

In total, we piloted with nine participants. We piloted with three women engineering undergraduate students, two woman engineering graduates, one man engineering graduate student, and three men engineering undergraduate students. We aimed to pilot mostly with women to match the target population of the larger study, but piloting with men allowed the lead researcher to gain practice and familiarity with the protocol, which added quality to the overall study. During each pilot interview, the interviewer went through the entire first interview protocol and a condensed version of the second and third interview protocols. We did this because the last two interviews were iterative and personalized to each participant in the data collection phase. Since interviews two and three were varied between the participants, full pilots were not necessary [17]. However, the condensed pilots allowed the interviewer to practice the semi-structured interview style, in which they planned to go off-script and ask participants follow-up narrative questions. The condensed interviews also allowed them to complete each pilot in one session, which saved time and motivated pilot participants to help without compensation.

Refinement

During and after each pilot, the interviewer used a set of questions to refine the protocols. First, they asked themself the following questions:

- Will I be able to write a story with this data?
- How did I alter the questions for participant understanding?
- When do I need to go off-script to flesh out participants' stories?

Then, after every pilot, the interviewer asked the pilot participant the following questions:

- Are there any other things you want me to ask you that I did not touch on?
- Do you have any comments/suggestions for my interview style (how I ask certain questions)?

The end-of-interview questions gave the researchers valuable feedback that allowed them to add questions that fill in interrogation gaps (e.g., question 1-14), eliminate questions based on redundancy, and alter the interviewing style to minimize confusing or leading questions. Results from the piloting phase included a refined three-interview protocol that measured women undergraduate students' experiences of EIJ and their own conceptualizations of personal epistemology.

Discussion and Future Work

We had two main takeaways from the piloting phase. First, to focus the interview questions on instances in participants' engineering educations that qualified as EIJ, a larger set of questions was used in interview one to garner a list of epistemic experiences. The line of interrogation in interview one did not qualify as a narrative interview [38], but to study a phenomenon as specific as EIJ, the questions were necessary. Interviews two and three had the closest protocols to a narrative interview, but the set of questions and follow-ups were iterative for each event from interview one. Though the pilot phase resulted in a departure from traditional narrative interview approaches [16], [33], the interview protocol developed for the three-interview structure aimed to achieve the goal of writing narratives about participants' experiences of EIJ and their impact on

personal epistemology. The extra questioning allowed for data collection with sufficient detail to craft multiple narratives.

Second, the quality of the larger study was increased from the invaluable training the lead researcher received in conducting semi-structured interviews to engineering students [38], [39]. Because the researchers aim to use direct quotes as most of the text in the resultant constructed narratives, the researcher had the responsibility in the interviews to highlight the voices of the participants while leading them on their narrative trajectories talking about EIJ. As mentioned, the interviews strayed from the traditional narrative interview style, but the researcher had to maintain the authenticity of the participant's speech. Through piloting, they were able to refine their skills and gain experiential knowledge in the balance of staying on-script and asking participant-specific questions. They grew comfortable in the interview setting as the interviewer, via videoconferencing and in person [40]. The researcher learned the skill of co-constructing knowledge with the participants. They learned when it was appropriate to offer clarification to a topic or redirect the interview as well as when to let the participant speak using their own interpretation of the topic within the context of their experiences. As a result of this quality added, the data collection phase (completed at the time of writing this paper) ran smoothly and promptly, and it yielded rich data from all participants to be constructed into narratives.

Future work in the larger study includes the continuation of the research process through data collection using the protocol instrument developed from the piloting phase and data analysis with narrative construction and smoothing. From the refined three-interview protocol, we collected data to construct two distinct narratives for each participant: a diachronic narrative detailing the participants' experiences of EIJ, and an interpretative narrative, in which the participants reflect on how their experiences impacted their personal epistemology [34]. To further quality testing on the three-interview protocol developed through this piloting phase, future work includes reflection on each interview question and how effectively it can be used to capture epistemic experiences. EER offers the interview quality reflection tool (IQRT) to facilitate this work [41]. To investigate work that is needed in the context of the intersection between EIJ, three-interview methods, and narrative analysis, future work includes expanding the target population of this research to faculty to explore other dimensions of EIJ within teaching and research experiences [42].

Conclusion

This paper details the piloting of the three-interview protocol for use in the data collection phase of a larger study in the Fall of 2024. We built baseline knowledge of the theoretical framework of EIJ to understand what we were measuring in the study design. Then, we outlined the data collection and analysis methods for the study. Once methods were established, we explained five stages of the piloting process: methods justification, building a preliminary interview protocol, peer review, piloting, and refinement. Lastly, we discussed the results of the piloting phase, including lessons learned to take into the data collection and analysis phases of the larger research study. The study benefitted from the piloting phase to increase quality in the data collection protocol and allow for the training necessary for the researcher to conduct narrative interviews. Also, because the phenomenon of EIJ is not explicitly understood by non-researchers, the research team felt the pilot was necessary to ensure that the line of questioning captured examples of EIJ. As a result, the study benefitted with time saved during an efficient data collection phase, which was completed at the time this paper was written.

Appendix A

Table 2: Pilot Interview Questions and Interviewer Prompts

Interview #-Question #	**Question**
1-01	What is your major?
1-02	What led you to choose an engineering major?
1-03	Before beginning your engineering major, how did you think about your abilities to understand or solve technical problems?
1-04	How do you think about your abilities to solve technical problems now?
1-05	What is your definition of engineering knowledge?
1-06	Overall, how would you describe your experiences in engineering (positive, negative, neutral)?
1-07	What were some moments that stood out to you in your engineering education? Specifically, were there moments you understood the concepts taught?
1-08	Were there moments you did not understand the concepts taught?
1-09	Were there moments the teacher played a role in your conceptual understanding (Teacher made learning easier or harder, teacher was helpful, etc.)?
1-10	Were there moments the teaching style of the instructor encouraged/discouraged your learning?
1-11	Were there moments you felt ill-equipped to handle what others wanted from you?
1-12	Were there moments you felt like your knowledge/intellect was heard/understood (in class, in teams, in study groups, internships, research, co-ops, conversations, etc.)?
1-13	Were there moments you did not feel like your knowledge/intellect was heard/understood (same contexts)?
1-14	Were there moments you witnessed someone else whose knowledge was treated unfairly in an interaction (someone else being undermined, ignored, or intentionally misunderstood)?
2-01	[You participated in a particular project/team/research group (recall information from interview 1).] This was a moment when you said you felt heard/valued/understood (or not). Can you tell me a story and take me through that experience?
2-02	Can you describe what happened next? Or What did you do next?

Interview #-Question #	**Question**
2-03	How did that make you feel? What was it about the interaction that made you feel valued/understood (or not)?
2-04	What were the direct impacts of that interaction?
2-05	What led up to that event?
2-06	How did this experience influence future events/decisions?
2-07	What was your overall takeaway from that experience?
2-08	Why does this memory stand out to you?
2-09	How do you think your gender affected your interactions in your engineering education?
3-01	You have in front of you a theoretical framework for personal epistemology, which is basically to help group the ideas you have into these categories so we can get an idea of the construction of your own personal epistemology. Do you have any questions about any of the categories (see **Error! Reference source not found.**)?
3-02	Have any new moments arisen in your engineering education since we last spoke (feeling heard/valued/understood or not)
3-03	How have your interactions [on the project/team/research group we talked about last interview] affected how you think about engineering knowledge or engineering concepts? • Source of engineering knowledge • Who gets to do engineering • What is valuable engineering knowledge • What does not count as engineering knowledge • Project-based versus lecture-based learning

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