

Enhancing Reflexivity in Qualitative Data Analysis: A Methodological Approach for Studying Engineering Students

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Enhancing Reflexivity in Qualitative Data Analysis: A Protocol for Studying Engineering Students

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1. Abstract

In this Full Method paper, we explain a procedure for reflexively analyzing qualitative data about engineering students. While reflexivity is crucial to understanding students' perceptions, experiences, and choices, well-structured and replicable methods for incorporating reflective practices in studies of engineering students remain limited. To address this gap, we developed a protocol for enhancing reflexivity in engineering education qualitative data analysis. We demonstrate our systematic, transparent protocol method using example semi-structured interview data gathered from a larger study of engineering transfer students at Sunshine University (pseudonym), a large, public, selective, research-intensive university in Florida. To demonstrate the flexibility of the analytic protocol, the sample includes students from various backgrounds and engineering disciplines.

Our layered protocol is grounded in Reflexive Thematic Analysis and takes influences from intersectional and anti-deficit frameworks. To enhance reflexivity in the analysis, we used research team positionality statements and participant demographic characteristics as inputs for deeper attention in the protocol. Our data analysis protocol, titled Intersectional Reflexive Analysis Protocol (IRAP), is as follows: first, while qualitatively coding, the researcher identifies instances when a student discusses aspects of their background; second, the researcher reflects on the passage in their reflexive journal noting initial thoughts; third, the researcher creates a profile card for each participant while acknowledging intersecting identities. Our multistep protocol facilitates researcher reflexivity on their positionalities and the participants' experiences.

Keywords: Qualitative Research, Interviews, Intersectionality, Reflexivity

2. Background

The characteristics of engineering students in the US have implications for engineering education research methods. Engineering students are not a monolith, and each year, the engineering field becomes more accessible for students from all backgrounds [1]. Each student brings unique motivations and experiences to their studies. Past researchers note the importance of analysis of STEM students across disciplines, demographic backgrounds, and life stages [2], [3]. Researchers must consider and reflect on students' individualities to deeply analyze their engineering education experiences.

In qualitative research in particular, reflexivity is necessary at each stage of the research process, yet there is little agreement on what constitutes "good" reflexivity [4]. Researchers engage in reflexive practices in a variety of ways, and intentional discussions about reflexivity are necessary in qualitative research [4]. In this paper, we contribute to reflexivity discussions by

describing our step-by-step analytic reflexive protocol for examining qualitative data in engineering education.

While tools exist for analyzing qualitative data, there is a lack of research establishing a replicable protocol for reflexive analysis in engineering education. We address this gap in our paper by proposing a protocol that incorporates existing methods for qualitative data analysis, including qualitative coding [5], reflexive journaling [6], and individual participant profile cards. Our protocol facilitates excellent qualitative research by ensuring sincerity, a characteristic of a research study with reflexivity and transparency about the researchers' subjective biases and values [7]. In this protocol, researchers document their reflexivity throughout each step, providing clarity of the analytic process.

We developed the proposed protocol while analyzing 11 qualitative interviews from current engineering vertical transfer students (students who transferred from a two-year institution to a four-year institution) and recent graduates at Sunshine University (SU), a pseudonym for a large public selective R1 university in Florida. Our interview sample included students across a broad representation of backgrounds. In this paper, we describe our reflexive analytical procedure and apply it using examples from our existing data. The purpose of this paper is to use our protocol on real data and illustrate its applicability, but we do not describe research findings in detail.

3. Intersectional Reflexive Analytic Protocol (IRAP)

In this paper, we refer to our data analytic protocol as **Intersectional Reflexive Analysis Protocol (IRAP)**, an intersectional, reflexive qualitative analysis protocol grounded in Braun & Clarke's Reflexive Thematic Analysis [6]. We start by explaining the overarching theoretical frameworks and lenses guiding the approach. Next, we explore the reflexive infrastructure embedded in the data collection and research design. Finally, we describe the steps in the process and use real data to illustrate the protocol in action. The analytic approach explains *how interpretation is oriented*, the reflexive infrastructure explains *what shapes reflexive attention*, and the analytic protocol explains *what researchers do in practice*. Together, these components define IRAP as a coherent, intersectional, reflexive analytic protocol.

3.1 Analytic Approach

In IRAP, we use Braun & Clarke's Reflexive Thematic Analysis (RTA) as an overarching qualitative analytic framework to data analysis [6]. RTA is a theoretically flexible approach to non-positivist qualitative research that embraces researcher subjectivity and reflexivity [8]. We also incorporated existing theoretical lenses commonly used in analyzing the experiences of engineering students: namely, anti-deficit [9] and intersectional [10]. Numerous education researchers utilize these lenses in previous qualitative research.

Shaun Harper's anti-deficit framework, rather than focusing on failures and gaps in STEM achievement among students from different backgrounds, identifies reasons for the success of underserved students in STEM [9]. Many engineering education studies exploring student success use a deficiency-oriented perspective (i.e. researching why students leave engineering) [11]. This approach affects dominant narratives of historically underserved engineering populations and limits potential interventions to support them [11]. When reflecting on our participants'

experiences, we prioritize identifying what they have and bring rather than perceived deficits in their backgrounds.

Kimberlé Crenshaw, through her analysis of Black women's experiences, developed the theory of intersectionality, which posits that all facets of a person's identity are co-constructed and inseparable [10]. Numerous quantitative engineering education researchers have previously explored intersectional academic outcome patterns through lenses of race and gender [12], [13]. Mentions of intersectionality have grown more common in engineering education research, but there is a need for more direct engagement with intersectionality as a theoretical tool [14]. In IRAP, we employ intersectionality as a lens to inform our reflexive process. This protocol does not train researchers to conduct full intersectional analysis but provides a structure for heightened analytic sensitivity to intersectional identities in qualitative research.

In this paper, these frameworks are not treated as standalone methodologies but as sensitizing lenses that inform analytic attention across qualitative traditions. These theoretical lenses are embedded within the specific analytic steps of our protocol, as we will explicitly show.

3.2 Reflexive Infrastructure

Elements of the foundation of IRAP support rigorous reflexive interpretation. These elements, positionality statements and participant demographic context, function as inputs to the protocol rather than self-contained background sections. Their role is to shape reflexive interpretation through the analytic process, not to describe the sample or researchers in isolation.

3.2.1 Positionality Statements

When studying engineering students from a variety of backgrounds, researchers' reflections on positionality are essential to methodological rigor, particularly in qualitative approaches that recognize the researcher as an analytic instrument [15]. In RTA, researcher subjectivity is not bracketed out but made visible to support transparent and accountable interpretation [6]. Accordingly, we include positionality statements to, rather than serve as biographical descriptions or to meet a checklist, clarify how researchers' backgrounds and roles informed the reflexive analytic process throughout the study [4], [16]. These statements articulate the nuances of each researcher's relation and insider/outsider status to the population under study [17]. Because researchers engaged with the data in different ways, positionality statements for the first and second author are presented separately to make these analytic roles and influences transparent. For each identity element described, we articulated how it shaped analytic engagement, such as guiding attention to particular patterns, prompting questioning of assumptions during coding, informing reflexive journaling, or contributing to team-based analytic discussions. Positionality was thus treated as part of the analytic method, supporting transparency and reflexive accountability, rather than as a biographical exercise.

3.2.1.1 First Author Positionality

The first author identifies as a White American woman Ph.D. student. She earned a bachelor's degree in chemical engineering before enrolling in a PhD program focused on engineering education research. Her primarily quantitative academic background necessitated intentional effort and substantial reflection in building a qualitative research mindset. She was a traditional college

student who graduated from high school, immediately enrolling in a university for four years before earning a bachelor's degree. Her educational pathway was different than the pathway of the transfer student population which she works with, influencing her approach to data collection and analysis. As the primary interviewer, the first author played a central role in data generation and initial interpretation. Due to differences in educational pathways compared to the participants, she approached the interviews with an empathetic, open mind and a willingness to hear others' stories [18]. Additionally, she leveraged her similarities with the participants (her engineering background and experiences with life transitions) to build rapport and relate to them, as she did not personally know any of them prior to their interviews [19]. The first author remained aware of her similarities and differences with the participants during analysis and of how her assumptions may have influenced her interpretation of the data. In alignment with RTA, she documented these influences through reflexive journaling to support transparency in interpretation.

3.2.1.2 Second Author Positionality

The second author identifies as a Puerto Rican engineering education researcher and serves as a faculty member with experience in qualitative and mixed-methods research on engineering students' educational pathways and institutional contexts. Prior to this role, she served as a tenured faculty member at a community college, which informed her analytic sensitivity to transfer pathways, institutional transitions, and structural features shaping students' experiences. In this study, the second author contributed primarily as an analytic and sensemaking partner through code review, interpretive discussion, and methodological guidance. She also serves as a faculty advisor to the Engineering Leaders in Transfer Engagement program [20], a research-informed initiative developed collaboratively with staff, students, and faculty to support engineering transfer students, which required reflexive attention to distinguish programmatic knowledge from participants' accounts and to avoid advocacy-oriented assumptions. Additionally, her personal proximity to transfer processes as the parent of a community college student transitioning to a research-intensive university required reflexive discipline to avoid projecting assumptions. Consistent with RTA, these influences were made explicit through collaborative analytic dialogue and documentation of interpretive decision-making.

3.2.2 Participant Demographic Data

In this paper, we apply our analytic approach to qualitative interview data from an exploratory study focusing on the experiences of engineering transfer students in Florida as they self-adjust to a new environment after transferring. This educational pathway is unique and requires researcher reflexivity, making it an appropriate sample for demonstrating an intersectional reflexive analysis protocol. To recruit students for our study, we first collected participant demographics via a self-reported survey, which we later used to inform reflexive attention during data analysis. All names used in this paper to reference participants are pseudonyms.

All participants had transferred to Sunshine University (SU), a pseudonym for a large public selective R1 university in Florida, from an institution in the Florida State College System. Due to the distinct educational pathway of the participants, each member of the research team considered this overarching context during analysis. Our sample included a mix of students of varying backgrounds and engineering majors. Because this analytic protocol is grounded in an intersectional framework, we explicitly avoid categorical essentialism, or the assumption that

social identity categories represent universal experiences [21]. Intersectionality emphasizes that identities and systems of power are mutually constituted and context dependent, meaning that participants' experiences cannot be attributed to single identity categories in isolation [10], [22]. Accordingly, demographic characteristics in this protocol are treated as contextual features that inform reflexive interpretation rather than as explanatory variables. This distinction is central to the proposed analytic approach and guides how participant identities are engaged throughout the analysis. While we did not explicitly collect survey data on these characteristics, during the interviews, participants also discussed their religious beliefs, socioeconomic status, and bilingualism. Our analytic protocol allows for flexibility with analysis of emergent identities, particularly through reflexive journaling and profile cards.

3.3 Analytic Protocol

To address the current gap in replicable reflexive research methods, we created a transparent, stepwise protocol for reflexivity in qualitative engineering education research. This protocol is named Intersectional Reflexive Analysis Protocol (IRAP), and there are three main steps: (1) identification; (2) reflection in reflexive journal; and (3) further reflection via profile card creation. The positionality statements and participant demographic contexts from the previous section function as analytic inputs across the three-step process. In the following section, we describe the procedure and include examples of each step in the sequence.

Step 1: Identification

The first step in our protocol is the identification of instances in which a participant describes an aspect of their personal background in the context of their engineering transfer student experience. The purpose of noting relevant segments of data was for further analytic reflection later. In our deductive coding process [5], the first author, along with undergraduate members of the research team, coded interview segments with the word "Intersectionality" when a participant described how an aspect of their background affected their engineering transfer experience, functioning as a flag to indicate a need for further analysis. Two researchers coded independently and then later convened to discuss their analytic processes. When the researchers' codes differed, they discussed their individual points of view, assumptions, and thought processes leading to their coding choices. These discussions facilitated reflection and metacognition, enabling researchers to reach agreement on the final codes. This crucial step underscores the rich rigor [7] of our qualitative data analysis. Table 1 contains an example of an interview excerpt and codes from the researchers:

Table 1. Deductive Coding Example

Row ID	Text	Coder #1	Coder #2	Code-Agreement
P0346	Pablo: <i>And the second reason was, so when I transferred, I was 27. Most of my, most of the students in my class were 18, 19. So huge age gap, right? So at some point I didn't have too much to speak with them, right? So I was kind of like that lonely wolf.</i>	Intersectionality	None	Intersectionality

In the above excerpt, Pablo expresses awareness of the age gap between himself and his classmates. Being older than many of them, Pablo viewed it as difficult to find commonalities with his peers and resonated with the “lone wolf” English idiom. Researcher 1 flagged this passage to invite further reflection in the context of intersectionality, as Pablo perceived his age as impacting his engineering student experience. While Researcher 2 did not initially categorize this passage as a discussion of identity, upon group review, the researchers assigned a code of “Intersectionality.” We found it crucial for multiple researchers to read and reflect on the data to avoid missing valuable information. We contend that group discussion is beneficial as it requires researchers to articulate their opinions and reach a deeper understanding of the data.

Step 2: Reflection

Throughout the coding and analysis process, researchers kept reflexive journals where they documented thoughts and reflections, as encouraged for researchers engaging in RTA [6], [8]. Each researcher can approach their reflexive journal in the most appropriate way for them, as long as they return to their journal entries for subsequent meaning-making [6]. When analyzing qualitative data from engineering students from a variety of backgrounds, it is especially important for researchers to keep a journal to log reflexive observations about students’ nuanced identities. For this project, researchers used their reflexive journals to note potential patterns, brainstorm theme ideas, and record overall thoughts. The following is a passage from the first author’s reflexive journal:

5/27/2025

Men vs. Women Participants:

Throughout the data analysis, I may see some differences between men and women participants and how they describe making friends. In general, male participants, such as Andrés, Grant, and Vincent, describe making many of their friends in their engineering courses. However, Hannah especially, talks about how the other students in her classes were standoffish and unapproachable and she needed to look outside of her classes to make friends. This also may vary by engineering department because a lot of the [DISCIPLINE] engineering participants talk about making friends in class. It also could be a gender thing because engineering is a more male-dominated field, so it could be harder for women to connect with the other students in their classes.

In the above passage, the first author notes initial thoughts on how identity impacts transfer students’ experiences. She observed that, from the sample, men participants often discussed engineering classes as an avenue to make friends, but women participants did not share the same experiences. She also reflects on other factors, such as engineering discipline, which may affect student perceptions. While the first author initially noted the differing experiences based on a student’s gender, she reflected further and identified engineering department as another potential factor. The reflexive journal provided her with space to contemplate and informally analyze the qualitative data. The reflexive journal ensures researchers have a place to make observations and comments on the data.

Step 3: Profile Cards

The final component of IRAP is to create a Profile Card for each participant. When analyzing qualitative data, we incorporate aspects of individual-focused idiographic approaches [23], which emphasize the perceptions of each individual rather than exclusively focusing on group commonalities. The Profile Card offers a space for reflection on the nuances of each individual participant's story and the individual characteristics of "what is it like" for each person [23]. For example, the following passage is an excerpt from the Profile Card section describing a participant's "Background and Context," where researchers "Describe the participant's life context as relevant to your study. This may include personal history, education, work experience, family background, or community ties." To determine what is "relevant to the study," we turn to the analytic flags from Step 1 and initial observations from Step 2 to reflect deeper.

Luz was born in [COUNTRY] and completed high school there. In [YEAR], she and her parents moved to Florida. In [YEAR], she enrolled in courses at [NAME] College because she perceived it to be easier (as an immigrant) to get started at a community college when compared to a four-year institution, and it offered her the opportunity to improve her English language skills. In her experience, the community college provided her with the guidance to pursue a pathway to a bachelor's degree from a Florida university. After completing English as a second language courses, Luz took academic courses, focusing on STEM, and she earned an associate's degree in [YEAR].

When describing an engineering transfer student's background and life context, their unique social and cultural identities are often relevant. In Luz's case, her immigrant and linguistic backgrounds were significant in her academic pathway choices. In her interview, she discussed how, as an immigrant, she was unfamiliar with the English language and the higher education system in the United States, so she hesitated to enroll at a four-year university. At the community college which she enrolled, Luz gained abilities to navigate the U.S. higher education system and ultimately transfer to a four-year engineering program. While some researchers may view Luz's immigrant status or nontraditional pathway as a deficit in her higher education experience, our analysis reframes her experience through an anti-deficit lens [9]. We focus instead on how, given her unique background, the vertical transfer pathway was the best option for her and afforded her opportunities that were less accessible if she attempted the traditional college pathway.

In the analysis, we also recommend practicing empathy as an analytic practice to reflect and interpret the data [24]. To this end, the first author pictured how she would feel in Luz's situation, while also acknowledging that she, as a U.S.-born American, will never completely understand the immigrant experience. The first author envisioned what it would be like to move to an unfamiliar country and attempt to navigate the higher education system there. This is an experience that the first author had never considered before. While reflecting, she understood that it would be easier to first enroll in the country's community college system and gain a foundation in a new language before pursuing a degree at a four-year college. Through empathetic reflection, the researcher developed a deeper understanding of the challenges of Luz's experience and the benefits of Luz's chosen pathway. We encourage all qualitative researchers to practice empathy in qualitative research to enrich their understanding of participants' unique lived experiences [24]. It is impossible for researchers to share every identity with every one of their study participants, but empathy as a reflexive practice can help researchers consider unfamiliar experiences.

Our Profile Card Template also includes a section explicitly devoted to Intersectional Reflection. In this section, researchers deconstruct a participant's multiple, overlapping identities and how the nuances influence students' experiences, interpretations, and opportunities. An excerpt where the first author focused on Hannah's religious background is as follows:

For this participant, her faith stands out to me. She is the only participant who mentioned making friends through a campus religious organization. In this case, her religion was a strength for her because it offered an opportunity for her to connect with other students through faith organizations. Other transfer students may not have this opportunity if they are nonreligious or members of faith traditions underrepresented on campus.

Hannah's use of her religious background to navigate her post-transfer environment is an example of how students utilize their identities to find community on campus. We did not explicitly ask students about their religious backgrounds, but the Profile Cards allowed us to reflect on unanticipated themes. As noted in the excerpt above, Hannah was the only person to mention religious organizations in her adjustment to SU. The Profile Card made space to analyze Hannah's unique experiences without necessitating similarities with other participants [23].

When exploring opportunities afforded to students through their identities, reflexive sensemaking also involves considering the structural absence of comparable opportunities for others. The first author did so in the above passage, noting that for students of faith traditions uncommon at SU, they may have fewer means of forming peer connections via religious student organizations.

We also encourage qualitative researchers to reflect on how similarities or differences between interviewers and interviewees can influence the interview discussion. In the following excerpt, the first author reflects on her conversation with Carla:

At first, Carla felt like she was out of place at her job because she was the only Hispanic woman in a group of White men. However, she later said that she did not experience discomfort in her SU classes. The interviewer, a White non-Hispanic American, does not have the same experience as Carla. I wonder if Carla would have shared more if she were interviewed by another Hispanic person. It is also possible that she did not perceive being a Hispanic woman as impacting her academic experience, but I am just wondering if the differences between interviewer and interviewee affected what Carla was comfortable with discussing.

The above excerpt illustrates the importance of an intersectional lens [10], as Carla expressed her lived experience as a Hispanic woman at her new job with predominantly White men. Carla did not speak about a similar experience in her SU courses, a distinction the researcher notes. The first author reflects on her positionality in the researcher-as-instrument dimension, which explores how researchers relate to the participants [15]. Visible identity differences between the interviewer and participant may affect the participant's comfort in the interview process and the information shared. We recommend that researchers reflect on their relations with the participants and how they may impact their conversations, as the researcher did above.

4. Conclusion

In this full method paper, we describe our development of the Intersectional Reflexive Analysis Protocol (IRAP) to examine qualitative data produced by engineering students of various backgrounds. Discussion of reflexivity in qualitative research is rare, so we address this gap by sharing our stepwise protocol for reflection. Our protocol advances qualitative analysis by operationalizing intersectionality and reflexivity within the broader RTA approach. Our protocol involves three steps: identification of discussions of identity, reflection in a reflexive journal, and creation of profile cards to promote deeper understanding. These three steps are built upon one another, deepening the researcher's reflexivity and engagement with the data. We demonstrated the protocol on example data of 11 semi-structured interviews from engineering vertical transfer students at a Florida university. Based on our protocol, we recommend the following best practices when reflexively engaging in qualitative data analysis:

- Use participant demographic data and researcher positionality reflection not as standalone information, but as tools to facilitate deeper awareness and analysis. This practice enhances the researcher-as-instrument dimension crucial to qualitative research.
- Build in multiple opportunities (such as reflexive journals and participant profile cards) to reflexively analyze qualitative data. More reflection spaces require researchers to consistently rethink their assumptions and interpretations, adding rigor to the analysis.
- Consider individual perspectives and experiences in addition to generating broader themes across participants. In IRAP, profile cards facilitate researcher reflection in the context of an individual's experiences, particularly through an intersectional lens.

While we acknowledge the limited scope of our data and the time-consuming nature of the protocol, we affirm the flexibility of IRAP and encourage future work to explore the use of IRAP in other research designs and populations. We contend that IRAP can be useful to enhance reflexivity and rigor for researchers performing qualitative and mixed-methods engineering education research, especially when exploring the experiences of engineering students from various backgrounds.

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6. Author Contributions

Conceptualization and supervision: Rivera-Jiménez conceptualized the original study and supervised the student researchers involved in the project. She also oversaw overall project coordination and secured funding. *Data collection:* Lubbe led the data collection. *Data preparation and analysis:* Lubbe cleaned and analyzed the data. *Protocol design:* Lubbe and Rivera-Jiménez co-developed IRAP. *Manuscript preparation:* Lubbe wrote the initial version of the manuscript. Rivera-Jiménez revised and edited multiple versions of the manuscript.

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