

Engineering Effective Conversations: Developing an Interview Protocol to Uncover Engineering Students' Preconceptions of Statics

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Abstract

Qualitative interviews are crucial in educational research for understanding student preconceptions and thought processes. This paper details the development of an interview protocol aimed at investigating student perceptions of Statics, a foundational engineering course. Initial findings showed that gathering student preconceptions was challenging, compared to their active perceptions and experiences. To address this, a comprehensive interview protocol was developed and refined using Clancy et al.'s Interview Protocol Development Process [1] and Castillo-Montoya's Interview Protocol Refinement Framework [2]. The protocol was refined through feedback and pilot testing, ensuring alignment with research objectives and conversational flow. This paper focuses on the development of the interview protocol. The ongoing study, with data collection planned for Fall 2024 and Spring 2025, aims to provide insights into student perceptions of Statics and the impact of student preconceptions on their experiences, offering guidance for future educational research.

Keywords

Statics, undergraduate, preconceptions, interview protocol, undergraduate student poster

Introduction

Qualitative interviews are critical in educational research, offering unique insights into participants' experiences and perceptions [3], [4]. This method is particularly valuable for understanding student thought processes, which is essential for developing effective teaching strategies and learning environments [5]. Moreover, student beliefs and attitudes they have entering specific courses can influence their achievement of learning outcomes, making it important for educators to explicitly address such preconceptions [6]. One such course in which students may enter with preconceptions is Statics. Statics is a foundational course in engineering curricula, serving as a prerequisite for several courses across various disciplines [7], [8]. Recognized as a 'gatekeeper' course, Statics exhibits high rates of students receiving low grades or withdrawing, underscoring the challenges that learners face [9], [10]. This gatekeeping effect makes understanding student preconceptions of Statics imperative.

This paper presents findings from the interview protocol development stage of a longitudinal study aimed at investigating student perceptions and experiences before, during, and after taking Statics. Preliminary findings indicate that gathering student preconceptions is more challenging than gathering their active perceptions. By developing a high-quality interview protocol, we can effectively uncover student preconceptions prior to their taking the course. This process includes aligning questions with research objectives, constructing a natural conversational flow, soliciting feedback for refinement, and pilot testing the protocol to ensure clarity and relevance.

Documenting this development process adds value to the engineering education field by guiding future researchers in investigating student preconceptions across various educational contexts.

Approach

The process for adapting the interview protocol followed a combination of Castillo-Montoya's Interview Protocol Refinement Framework [2] and Clancy et al.'s (2022) Interview Protocol Development Process [1], as shown in Figure 1.

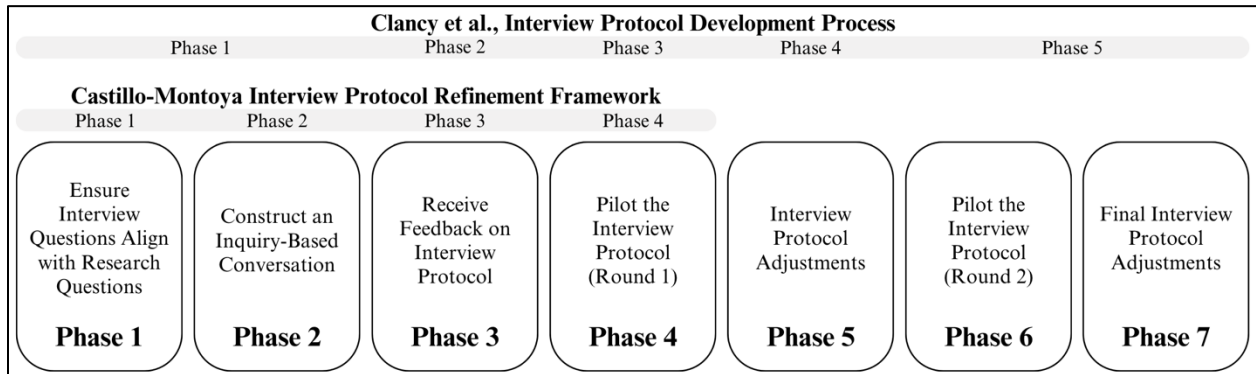


Figure 1. Combined Frameworks Used to Adapt Interview Protocol

Phase 1: Ensure Interview Questions Align with Research Questions

As the first draft of interview questions were established by Fitzpatrick, the research team met to confirm the purpose and necessity of each question. To confirm a question was purposeful and necessary, the question was compared to the research question of interest. Since this interview process aimed to answer a singular research question, a simplified version of Castillo-Montoya's Interview Protocol Matrix was used [2]. Using the matrix confirmed that each question aligned with the research question or a goal of the study (i.e., background or well-being information). If the research team did not agree that the interview question was aligned with the study appropriately, the team discussed their perspectives until they reached consensus.

Phase 2: Construct an Inquiry-Based Conversation

The interview protocol was revised to consider the context and flow of the predicted conversation. The author team worked to simulate the future conversations from the questions asked and the context known about the participants. Understanding that the interview participants are primarily rising second-year engineering undergraduate students, any technical jargon was replaced with everyday language. Fitzpatrick, who is a rising fourth-year engineering undergraduate, easily translated any technical jargon into more casual terms. The questions were adapted to maximize comprehension for the participant and foster a conversation that progressed naturally. These adaptations ensured the participants felt comfortable sharing their perspectives without interference of unknown terms or protocol structure.

Phase 3: Receive Feedback on Interview Protocol

Fitzpatrick consulted peers, including undergraduate and graduate students versed in engineering education research, to provide feedback on the interview protocol. These peers were asked to make recommendations on the syntax and vocabulary of the questions, the prompts following

each question, the order of the questions, and if they thought any questions should be added or removed. Upon receiving the feedback, the author team met to revise the protocol. Feedback that enhanced the protocol’s ability to be clear, simple, and easily answered were prioritized.

Phase 4: Pilot the Interview Protocol (Round 1)

The pilot interviews were conducted with two participants who met the screening criteria of the study. While piloting the protocol, one author carried the conversation with the participant while the other took notes about the conversation and possible improvements to be made, as shown in Table 1. Upon conclusion of each interview, the author team met to discuss and reach consensus on the changes.

Phase 5: Interview Protocol Adjustments

The notes made in Round 1 of piloting and their respective changes are shown in Table 1.

Table 1. Round 1 Piloting Process

Note	Change
Participant 1’s interview took 15 minutes. The protocol was expected to take 45 – 60 minutes.	The author team added additional prompts to capture a variety of angles on certain topics.
Participant 2 mentioned working during the school year.	Specific questions about participants’ work situation were added, including number of hours, motivation for working, and impact on their school experience.
The conversations seemed a bit impersonal. The participants did not easily go into depth with many responses.	The protocol was changed to ask more personal questions to the participant to evoke richer stories.
The protocol lacked relevance to the individual participant.	A question was added to ask about their story of becoming an engineering student. They were asked about their motivation to pursue the discipline and how the course plays a role in their own story.
Participants often used terms such as ‘weed-out,’ ‘rigorous,’ and ‘challenging’ when referring to the course.	The author team agreed to inquire about the participants’ definitions of such terms if they use them in order to better understand their perspectives.

Phase 6: Pilot the Interview Protocol (Round 2)

Two more participants, who met the screening criteria of the study, were recruited for the second round of piloting. One author conducted the interview while the other took notes. Upon conclusion of the interviews, the author team met to discuss and reach consensus on the changes.

Phase 7: Final Interview Protocol Adjustments

The notes made in Round 2 of piloting and their respective changes are shown in Table 2. Upon completion of Phase 7, the final interview protocol was established, as depicted in Table 3.

Table 2. Round 2 Piloting Process

Note	Change
The protocol did not spark much reflection among the participants.	A question was added: “If you could ask your future self who has already completed the course a question about Statics, what would you ask?”
Participant 3 mentioned their anxiety about the course and its anticipated challenges.	Additional questions were added to the section on well-being and outside commitments.
When asking participants about their engineering story, the timing of the question was not ideal.	The question was moved to an earlier section.

Table 3. Interview Protocol Content

Protocol Section	Section Content
Background	<ul style="list-style-type: none"> • Student academic background <ul style="list-style-type: none"> ○ Year in school; major of study; number of credit hours enrolled ○ Personal engineering journey
Initial Understanding	<ul style="list-style-type: none"> • Knowledge of Statics <ul style="list-style-type: none"> ○ Course content / topics covered ○ Awareness of previous exposure to course topics ○ Purpose of the course • What they have heard about Statics from peers / professors <ul style="list-style-type: none"> ○ Common challenges / difficulties / successes ○ Advice on how to succeed / words of caution
Preparation & Confidence	<ul style="list-style-type: none"> • Feelings about starting Statics <ul style="list-style-type: none"> ○ Aspects they are excited / confident / nervous / worried about ○ Anticipated grade in the course • Resources available <ul style="list-style-type: none"> ○ What is available to them and/or they plan to use ○ What resources they wish were available
Well-Being & Outside Commitments	<ul style="list-style-type: none"> • Personal challenges / barriers that may impact their experience in Statics <ul style="list-style-type: none"> ○ Work commitments / motivation for working ○ Plans to balance work and school • Overall well-being <ul style="list-style-type: none"> ○ Previous positive / negative experiences ○ Anticipated positive / negative experiences
Final Thoughts	<ul style="list-style-type: none"> • Question they would like to ask their future self about Statics • Additional thoughts, feelings, or concerns

Future Work

The broader longitudinal study is ongoing. There will be two cohorts of participants, which will be separated by the Fall 2024 and Spring 2025 semesters. The future data collection plan is depicted in Figure 2. Upon completion of data collection, the interview and reflection data will be analyzed through an iterative open coding process. The findings of this project will aim to inform future researchers exploring the gatekeeping nature of Statics and the impact of student preconceptions.

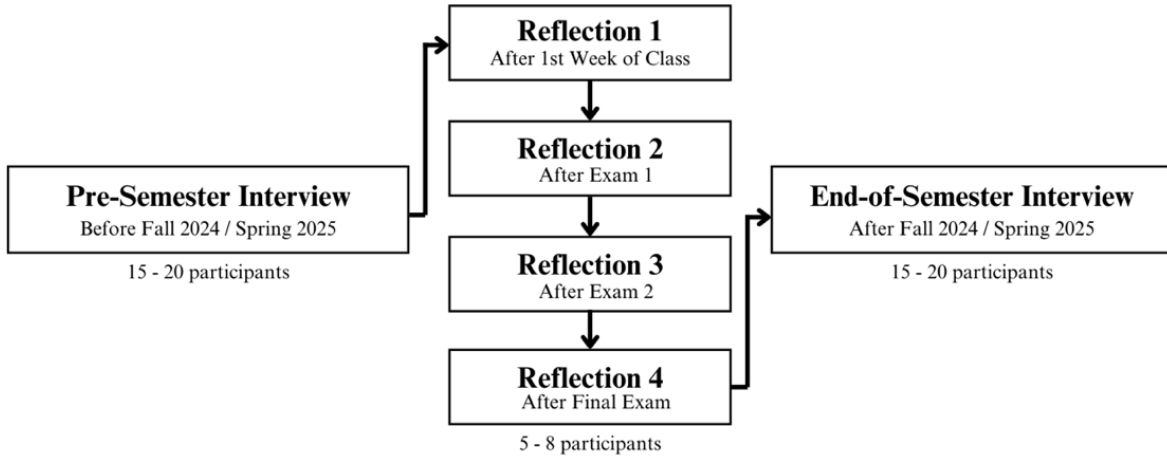


Figure 2. Future Data Collection Process

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