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Revoicing in Undergraduate Physics Education: a Case Study

by

Elizabeth Noël Olson

A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

In

Physics

Minnesota State University, Mankato

Mankato, Minnesota

May 2019

May 15, 2019

Revoicing in Undergraduate Physics Education: a Case Study

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Revoicing in Undergraduate Physics Education: a Case Study
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Master of Science in Physics
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May 2019

Abstract

When an instructor repeats or “revoices” the words or ideas that a student has just said, what is the instructor’s goal? What results can this tactic bring? In order to lay the groundwork for a broader investigation of these questions, video recordings were viewed of one-on-one interviews of students populating a discussion-based modern physics-like course taken by non-physics science, technology, engineering, and mathematics (STEM) majors at a medium-sized public university. This work focuses on a one particular interview which reveals several functions of this revoicing technique. For the interview in question, revoicing instances were identified and put into three inflection type categories: declarative, interrogative, and ambiguous. The types of student responses to each instance were then identified and categorized by the level of student engagement they represented. Student engagement level was then compared for the various inflection types of the revoicing instances. It was found that interrogative revoicing had a higher likelihood of resulting in a response with a high level of student engagement, whereas declarative revoicing resulted more often in a response with a low level of student engagement. In the future, additional interviews from the data set can be analyzed to determine if this same pattern of engagement level holds for other students.

Keywords: revoicing, physics education, video data, interview, student engagement, vocal inflection

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Introduction

As a laboratory instructor interacting with students, my goals are to understand what students want to know and to guide them to find that knowledge. The interactions I have with my students are formulated to help them arrive at the answers to their own questions as independently as possible. I may have secondary goals, such as building rapport with my students, but my main objective is to help the students learn to do the experiments.

As such, I have noticed myself using a variety of techniques during conversations with my students. Sometimes I ask them questions related to their original question. Sometimes I provide them with specific pieces of information that will help them answer their question on their own. Sometimes, when I need to know more about what they are thinking so I know how to help, I ask them for more information about their ideas.

Occasionally, I also use a strategy of repetition of words or ideas the students have previously articulated. This strategy has been called revoicing (diSessa, Greeno, Michaels, & O'Connor, 2016; Herbel-Eisenmann, Drake, & Cirillo, 2009; O'Connor & Michaels, 1993; Yifat & Zadunaisky-Ehrlich, 2008).

This work will focus on revoicing as a conversational strategy for university-level physics instructors, unpacking the mechanics of the technique in a one-on-one setting and illuminating its set of possible outcomes in that context. The goal is to lay the groundwork for further study on revoicing in various physics education contexts, in order to eventually provide educators with a better understanding of how the technique actually works and enable them to make informed choices about when the strategy may or may not be an appropriate choice for their objectives in specific conversations with their students.

What Is Revoicing?

Originally a concept from semiotics (Bakhtin, 1981, 1987), revoicing was brought into an education context and given a specific definition by O'Connor and Michaels (1993). Revoicing happens in a conversation between two or more people when one person repeats something said by another person involved in the conversation (O'Connor & Michaels, 1993), and can include a verbatim repetition of the other person's words or a simple rephrasing of his or her idea(s). It often follows a pattern similar to this: "So you're saying that [rephrased idea]."

Revoicing instances can contain several parts, which are described slightly differently by several authors who investigated revoicing in various education contexts (diSessa et al., 2016; Herbel-Eisenmann et al., 2009; O'Connor & Michaels, 1993). I have combined their characterizations into one description below.

Revoicing can contain the following elements:

1. a discourse marker such as the word "so,"
2. an attribution such as the word "you" or the student's name,
3. a verb such as "think" or "say" which gives the relationship between the person being revoiced and the idea being revoiced,
4. a reformulation of one or more ideas mentioned by the person being revoiced *or* a verbatim repetition of the person's words, and
5. a request for validation, such as "Is that right?"

Revoicing does not include instances when the words or ideas are uttered as part of another question, with leading words such as "Why" or "In what case."

Elided Forms

DiSessa et al. discuss "elided forms" (2016, p. 351) of revoicing which omit some of the revoicing elements listed above. As the current analysis will reveal, all

the revoicing instances discussed in this work are elided forms that omit the attribution (element 2), verb (element 3), and verbal request for validation (element 5). Some of the revoicing instances seen in the data include a discourse marker (element 1) and some do not. All contain a reformulation or repetition (element 4).

DiSessa et al. (2016) also mention that variations in tone of voice could allow all portions but the reformulation to be omitted from some revoicing instances. Accordingly, one focus of this research project will be the effects of these types of variations on the outcomes of revoicing instances.

Speech Characteristics of Revoicing Instances

Several researchers have mentioned variations in speech characteristics among revoicing instances. As mentioned above, in their discussion on elided forms of revoicing, diSessa et al. mention “a (possibly skeptical) questioning tone” (2016, p. 351) which could affect the form and function of a revoicing instance. Yifat and Zadunaisky-Ehrlich also mention the existence of “prosodic cues (pitch, timing, syllable length, rhythm, etc.) that accompany ... [teachers’] revoicings” (2008, p. 214). According to Herbel-Eisenmann et al. (2009), teachers themselves have awareness of these types of variations. In a group discussion, teachers mentioned how both context of a revoicing interaction and qualities about it such as tone of voice and pauses could potentially impact both the way the interaction unfolds and the way the student interprets the interaction (Herbel-Eisenmann et al., 2009).

This project investigates the effect of one group of prosodic cues on student responses for revoicing. Here, the cues of interest are vocal inflection patterns that suggest that the speaker is asking a question, indicate that the speaker is making a statement, or are ambiguous in nature. These inflection patterns will be called “interrogative,” “declarative,” and “ambiguous,” respectively (see *Main*

Analysis—Development of Final Coding Scheme—Coding scheme refinement—Inflection pattern codes).

Other Meanings of Revoicing

In certain cases, researchers have given the term “revoicing” definitions that do not apply to this study. For example, some have used the term “revoicing” to mean dubbing voices over a film in a different language (Baños & Sokoli, 2015). Others (Lee & Moon, 2013) use Bakhtin’s (1981) revoicing concept to refer to a method of teacher reflection in which teachers take information related to teaching, internalize it, then apply it to their own situations. Neither the dubbing nor the teacher reflection definitions apply to this study.

Revoicing in Context

This research project intends to discover some of the possible outcomes of revoicing in a specific undergraduate physics context that combines features of classroom instruction and clinical interviewing.

Revoicing in the Clinical Interview

Clinical interviewing involves a discussion between two people in which one of the people, the interviewer, attempts to understand something about the way the other person, the interviewee, thinks. This context overlaps with my work in that the data for the project at hand involves a one-on-one conversation in which a physics instructor is, at least in part, attempting to gain insight into aspects of a student’s thinking about course materials (see *Preliminary Steps—Interview Contents*). Therefore, previous work on revoicing in clinical interviewing provides insight for this project.

In his work *Entering the Child's Mind: The Clinical Interview in Psychological Research and Practice*, psychologist Ginsburg (1997) referred to “echoing” as a technique for seeking information when interviewing children. (This “echoing” recalls “elided forms” of revoicing from diSessa et al., 2016, p. 351.) Drawing from his extensive personal experience conducting clinical interviews, he shared an anecdote about using the technique in a moment when he asked the child a question and he did not completely understand the meaning of the child’s response. At that moment, he chose to echo what the child said and see how the child responded. Ginsburg also described using the technique to draw out more information even when he understood what the child was saying.

Notably, Ginsburg remarks that in these interviews with children, the echoing technique may not have been suited to the early parts of the interview; instead, the technique might have been more useful “after [the interviewer had] already established the ‘rules of the game’ ” (1997, p. 144). By “the rules of the game,” Ginsburg referred to the mechanics of the interviewer’s questioning and the child’s answering during the conversation between the two, and the child’s awareness of and compliance with these mechanics.

DiSessa et al. (2016) also used clinical interviewing, in an education context rather than a psychology context. In this case, the original purpose of the clinical interviews had been to investigate a university student’s physics knowledge. DiSessa et al. revisited the video data for a new purpose, to investigate revoicing in clinical interviewing.

According to diSessa et al. (2016), clinical interviewing could be helpful for gaining insight into students’ knowledge. Indeed, in a setting such as the oral exam interview, which is similar to a clinical interview, part of the instructor’s goal could be to gain a better understanding of a student’s knowledge. Of course, the instructor

could have other goals, as well, such as investigating the student's problem-solving skills or reasoning. A small glimpse into the instructor's motivations in the study at hand can be seen in *Preliminary Steps—Interview Contents*.

Revoicing in the Classroom

Education settings can include a variety of contexts, including whole-class interactions, small groups, and one-on-one interaction. One-on-one interaction is the education setting that most closely matches the context of the data chosen for this research project, which shows a one-on-one interview between a student and an instructor which functions as an oral exam.

Education settings also vary by difficulty level. Elementary classroom settings and university classroom settings can differ in many ways, but the educational focus remains the same. Therefore, although revoicing research at the university level provides a closer match to the context of this work, research done at the elementary level also offers helpful insight.

O'Connor and Michaels (1993) were the first to bring revoicing research into an education setting, when they examined revoicing carried out by two experienced elementary teachers. They explored how revoicing may allow instructors to direct the flow of a task while also providing guidance to students about the roles they can take on in the classroom and how to assume those roles. They point out one example where, according to their analysis, a teacher used revoicing for two purposes. First, revoicing was used to provide an alternative "reformulation" of what a student had said. Second, revoicing was used to "lend power and authority to the student's relatively weak voice" (O'Connor & Michaels, 1993, p. 327).

O'Connor and Michaels (1993) also note that in the elementary classroom environment

the consequences of a revoicing move for a particular student are mediated in part by the reaction of the physically present audience. Thus, a full account of the teacher's revoicing move would make reference to aspects of audience design that include taking account of overhearers and other third parties. (O'Connor & Michaels, 1993, p. 334)

These characteristics are not a concern with the study at hand, because it explores revoicing in a one-on-one setting rather than a group setting.

Yifat and Zadunaisky-Ehrlich (2008) investigated revoicing at the preschool and kindergarten level. They mention how "classroom talk is often referred to as an institutional or instructional form of discourse (Linell, 1998), in which turn-taking and participation are restricted, and responsibility for managing and monitoring the progress of discourse belongs to the teacher" Yifat and Zadunaisky-Ehrlich (2008, p. 218). This statement refers to a classroom of students with a teacher. However, one can imagine how a one-on-one discussion between a student and a teacher such as an oral exam interview could be similar, with the student deferring to the teacher to direct the conversation.

Internal Motivations and Outward Effects

Past research on revoicing has involved discussions with the person completing the revoicing regarding his or her motivations for using certain techniques (diSessa et al., 2016). Other researchers at least had access to the teachers who used revoicing in their classrooms, though it is not obvious if the researchers discussed internal motivations with them (O'Connor & Michaels, 1993). However, projects that rely on video data alone, such as this case study (see *Preliminary Steps*), do not have the advantage of direct communication with the instructor completing the revoicing or the student who is being revoiced. Therefore, these types of projects do

not have direct information about the thoughts and motivations of the instructor or student. This lack of direct information provides a challenge when it comes to determining the pedagogical or social motives of the instructor or student at any point in their conversation.

Yifat and Zadunaisky-Ehrlich approached educational revoicing by looking at “pedagogical actions” (2008, p. 218) taken by teachers by means of revoicing. Thus, Yifat and Zadunaisky-Ehrlich chose to classify their data in categories that answer the question, “What action is the teacher taking?” However, rather than coming from the perspective of “What action is the teacher taking?” I have chosen to ask “What can be observed about the conversation?” Whereas the first question implies intent on the part of the teacher, the second looks at characteristics of the conversation and avoids any direct implications of intent.

Since video data alone does not show the instructor’s intentions for revoicing but does show the effects of revoicing, this project will focus on the outward effects of revoicing in the conversation rather than attempting to infer the instructor’s motivations for using revoicing. Although student and instructor intentions cannot be directly observed from their interactions, certain verbal and physical characteristics of the interactions themselves *can* be directly observed. Some of these characteristics could include word choice, prosody, physical posture, and gestures. The approach of this study will be to gain information regarding the conversational functions of revoicing by observing these types of characteristics.

Preliminary Steps

The preliminary steps of the research project involved selecting a set of data on which to focus. My original goal was to investigate how undergraduate students studying middle- or upper-level physics viewed the nature of science, so I chose to

use video data for my research, in the hopes that the students' video-recorded interactions and verbal communication would reveal information relating to these views.

Why Video Data?

In their work outlining a process for using video data for educational research, Engle, Conant, and Greeno (2007) provide several arguments for choosing to use video data rather than other types of data such as audio recordings or classroom observation codes. Among other reasons, they highlight how for their study, video data allowed them the freedom to investigate an unexpectedly interesting incident in addition to their previously anticipated objectives.

The choice to use digitally-recorded video data for the project at hand had a number of benefits and drawbacks, which are listed below.

Benefits included

- richness of content, as video data includes both a continuous visual record and a verbatim audio record (except in portions with unintelligible audio);
- analysis tool availability (see *Exploratory Analysis—Development of Initial Coding Scheme*);
- ability to revisit data that was gathered for a different project;
- ability to watch the data with an open, curious mind, and see what emerged as being an interesting phenomenon, rather than by necessity having strict, specific goals prior to viewing the data;
- lack of work hours required to gather data; and
- ease of viewing any moment of the data at any time.

Drawbacks included:

- Occasionally, it was difficult to understand the words spoken on the audio

recording, though this issue occurs with any recorded data and was rare in this particular set of recordings.

- In the early stages of the project, the video data seemed overwhelmingly rich with possible pathways of investigation. (This drawback was mitigated by the emergence of an appropriate strategy for the first watch-through of the data, which is described below in *Exploratory Analysis—Initial Data Review—Scanning the data for salient moments.*)

- The data set was not quite complete; latter portions of the video were missing for several students' interviews. This would have been more of a drawback had the project continued beyond this case study.

In the end, the benefits from the use of video data far outweighed the drawbacks and made the choice worthwhile for this project.

Choosing Archival Video to Investigate

When I started looking at data, I had access to several sets of video data recorded for previous research projects at a large R-1 university. The data included video of both in-class settings and one-on-one interview settings related to undergraduate mid- or upper-level physics classes.

Since I had been planning to investigate how students viewed the nature of science, I surveyed the available data with that goal in mind. Out of all the videos available, I chose one set that I found intriguing and seemed like it had potential to reveal something about the nature of science beliefs of the students.

This set included videos of eight non-physics Science, Technology, Engineering, and Mathematics (STEM) majors in one-on-one interviews with their instructor. These students had previously completed their university's calculus-based introductory physics course series and were now taking a heavily concept-focused

course on modern physics. The interviews served as an oral exam for their course, a class which covered concepts from modern physics. Each interview was conducted by the same person, the instructor for the course.

Interview Contents

The interview videos showed a view of one side of a small room, with a small table and chairs and a whiteboard on the wall in the background. In each video, the instructor sat on one side of the table and a student sat either across from the instructor or adjacent to the instructor. Most of the videos afforded a clear view of the gestures and facial expressions of both the student and the instructor.

Throughout each video, the instructor and student covered several topics. The instructor followed a loose format, starting off with a similar question for each student regarding the class in general, then narrowing the focus to specific topics covered by the course during the semester preceding the interview. In the video that would eventually be chosen as the focus of this case study (see *Exploratory Analysis*—), the following main topics were covered: the utility of various models in science, the differences between theories and laws, special relativity and the twin paradox, and fission and fusion.

In one of the interviews, when asked about the purpose of the interview by a student, the instructor responded in part that the oral exam was meant to reveal the students' "thinking [processes]" about the course content and their skills at "[recovering] from being stuck." This mindset is evident throughout the videos, particular when the instructor prompts the students to work out the answers to questions by taking logical steps. Occasionally, the students were able to follow the instructor's lead and arrive at reasonable answers to their questions. In other instances, students did get "stuck" and the instructor turned the conversational

focus elsewhere.

Exploratory Analysis

After choosing video data to explore, I looked to Engle et al. (2007) for guidance on how to proceed with my analysis.

The Process of Video Research

In their book chapter called *Progressive Refinement of Hypotheses in Video-Supported Research*, Engle et al. (2007) describe their process for conducting educational research using video data. These researchers approached the video data with a specific topic of interest in mind. After initially reviewing the video and isolating a salient incident to examine further, the authors then asked additional questions about the incident. They suggest the following protocol, which they followed in their research:

1. View data repeatedly with multiple people and brainstorm ideas to answer your research question(s).
2. Simplify your descriptive model so it is more generalizable and useful in the body of literature.
3. Use additional data surrounding your case to make your model more polished and more specific.
4. Explain other cases with your model, expanding the generalizability of your work.
5. Use your model to develop suggestions for good classroom practice, taking into account additional data that includes other scenarios.

As the following sections will reveal, the project at hand encompassed steps one and two. First, I completed an initial data review, choice of salient moment (in

this case, salient video for one initial case study), additional inquiry, and repeated viewing (in this case, solo viewing rather than in a group). Finally, I simplified my descriptive model and revised my data coding based on these simplifications. In some cases, these processes were iterative. For example, simplification of descriptive models happened between repeated viewings of portions of the data. Future research could include steps three through five of the protocol listed above.

Initial Data Review

After choosing the data, I began step one from the above list by watching the nine interview videos from the data set in a focused manner.

Scanning the data for salient moments. As a loose guide for my first watch-through of the data set, I looked to the Engle et al. comments about creating a content log (2007, p. 244). The goal for this stage of the project was to observe the topics discussed by the instructor and the student in each video and type a list of them for each student. I also planned to note occasions where the students' words potentially revealed information related to my original topic of interest, the students' understandings of the nature of science. Finally, I planned to mark time stamps of anything else that seemed interesting about the interactions. Following this plan, I created a document for each student and made my first in-depth foray into the data set.

Watching the video with a critical eye took acclimatization, so I did not take many notes beyond the bare minimum during the first watch-through. My initial notes for Students A, B, C, D, E, and F mostly concern the conversation topic lists, with a few additional observations. However, as I reached the final two videos—those of Students G and H—I became more adept at making observations from the data, and my initial notes were more extensive for those two videos, having

recognized many more salient moments than I did for Students A through F.

A noteworthy situation. When I reached the eighth and final video, something unexpected caught my attention about the interactions between the student (“Student H”) and the instructor: during much of the conversation, the two physically mirrored each other! For example, towards the beginning of the conversation, both Student H and the instructor leaned forward with their elbows on the table between them and one or both hands near their faces, elbows resting on the table. Then, a minute later, the student leaned back from the table and the instructor followed suit. At other times in the conversation, both people leaned back with arms in a relaxed, open posture, hands in their laps. Intrigued by this phenomenon, I added “physical mirroring” to my list of things to observe during my second watch-through of the videos.

Strategy for the second watch-through. Though my initial video notes were fairly sparse, watching the videos for the first time provided me with a bounty of ideas to potentially investigate. After considering what I had seen in the videos and thinking about what I had initially planned to explore—the nature of science—along with what seemed most intriguing in the videos—instructor-student mirroring—I came up with a long list of aspects to monitor in the next watch-through. Among other things, I planned to observe

- questioning tactics,
- nature of science misconceptions,
- instructor-student mirroring (both verbal and physical), and
- student demeanor.

Due to the quantity and subject matter diversity of these items, the beginning of my second watch-through had a more scattershot approach than that of the first. However, I did not try to keep track of every single notable occurrence. My focus

was on choosing a topic to study, so I took notes on the events that jumped out at me, keeping the above list in mind while I watched.

A pattern emerges: instructor-student mirroring. As I watched the videos for the second time, I began to notice increasing numbers of salient moments in each video. While the videos did seem to provide information related to the students' understandings of the nature of science, I became fascinated by the mechanics of the conversations rather than what they revealed about that specific topic. After watching several interviews for a second time, certain patterns emerged that appeared to be either interesting or important to the direction of the conversations. The patterns that seemed particularly salient involved mirroring or copying of the instructor by the student or of the student by the instructor.

This copying occurred in two forms: physical and verbal. Physical mirroring occurred when either the instructor or the student adopted similar physical mannerisms and/or posture as the other. Verbal mirroring occurred when the instructor or the student repeated words or ideas spoken by the other. After seeing the videos of Students A through E for a second time, I began to realize that I wanted my research to focus on this mirroring, particularly the verbal form which I initially labeled "echoing."

Following this realization, I discontinued the second watch-through during the middle of the Student F video. The second watch-through had achieved its purpose: I had discovered a topic of interest which would be further refined in the next steps of my project.

Development of Initial Coding Scheme

After the focus of my research transitioned from the nature of science to instructor questioning techniques in the form of verbal mirroring, I switched

note-taking techniques, as well. Instead of typing notes into a document, I would now use a computer program called Behavioral Observation Research Interactive Software (BORIS) to time stamp instances of various questioning techniques in the videos.

BORIS is a computer program (Friard & Gamba, 2016) that allows the user to log the following information about events from video data:

1. the time of occurrence of a “point event” or the beginning and ending times of a “state event,”
2. what type of event occurred, and
3. which subject initiated the occurrence.

The software has numerous other capabilities, including one that was useful for my project: BORIS can store notes about each individual event that the user chooses to log. Thus, I was able to use BORIS to time stamp occurrences of revoicing from the video data and make notes about them.

Focusing on Student E. At this point, I needed to choose one interview to use for developing my coding scheme. One interview, that with Student E, stood out due to its many instances of verbal mirroring, so it became the center of my analysis. Indeed, the Student E video would prove fruitful, providing the basis for the rest of this case study.

Preliminary coding strategy. After choosing the Student E video for focused analysis, my next step was to create and refine a coding scheme for verbal mirroring events and to time stamp instances of each coding category in the Student E video using BORIS. Initially, I intended to log two types of instructor questioning and three types of student responses, as shown in Table 1. The instructor questioning codes would indicate the type of strategy employed by the instructor in each instance (either “Echoing” or “Say More About That”), and the student

Table 1

Preliminary Coding Scheme

Subject	Code	Description
Instructor	Echoing	Instructor repeats what student says
	“Say More About That”	“Say more about that,” “Tell me more,” or similar phrase
Student	Toward desired path	Student goes closer to desired pathway of conversation
	Away from desired path	Student moves away from the desired path of conversation
	Ambiguous result	

response codes would indicate the conversational trajectory of the student’s responses as seen from the instructor’s perspective (“Toward desired path,” “Away from desired path,” or “Ambiguous result”).

However, while logging the first few instances in BORIS, I began to wonder if discerning whether the student responses were away from or toward the instructor’s desired path of the conversation was even possible with the available data and time frame of the project. I was wary of making assumptions which did not have clear evidence in the data, and without other evidence such as a direct interview with the instructor following each oral exam, it seemed unlikely that I could discern the instructor’s goals with any level of certainty. Therefore, these “desired path” classifications seemed out of reach for this project. I needed more information about instructor techniques before I could choose a different way to categorize student responses.

For the above reason and in order to make the coding process simpler and faster, I decided to split it into two stages. First, I would log instructor questioning techniques. I would log student responses later, after taking time to create more appropriate student response codes.

Initial categories. Therefore, I began to code just the instructor questioning techniques for the video with Student E. My initial codes were the two Instructor codes listed in Table 1: “Echoing” and “Say More About That.”

Echoing. The code “Echoing” was used to mark moments when the instructor repeated something the student said. Initially, I included instances with additional question words, such as “Why” or “In what case.” However, I soon changed my definition of echoing to exclude these occasions. From then on, echoing did not include occasions when the instructor added words to make the repetition of the student’s words a question. (I would later learn that this was consistent with the definition of revoicing.) However, it did include occasions with a variety of vocal inflections (see *What Is Revoicing?*).

During the coding process, I noticed that, on occasion, several echoing instances would occur in quick succession. When the instructor’s tone of voice and body language indicated that these instances were individual revoicing events, they were counted as such. One instance occurred when the instructor received confirmation about parts of her revoicing from the student while she was still speaking, but on that occasion, the instructor’s body language and tone of voice indicated that she was still completing her thought. Therefore, that instance was counted as one revoicing event.

“Say more about that”. The “Say more about that” category was to include instances when the instructor requested that the student continue to discuss a previous point or topic of conversation. As Table 1 shows, this category also included any other phrase (e.g., “Tell me more”) with a similar meaning to the phrase “Say more about that.”

Additional categories emerge. At this stage of my project, I was trying to gain a clearer picture of the data so I could understand what phenomena it might

demonstrate. As I began to code instances of echoing and “Say more about that,” I noticed the instructor using several other strategies that created a broader picture of the instructor’s strategy than the two initial categories alone.

Follow-up question. One of these other strategies occurred when the instructor asked the student a follow-up question. Many of the follow-up questions incorporated words or ideas from the student, so initially I placed them in the echoing category. However, other follow-up questions did not incorporate words or ideas from the student, so I decided to group all the follow-up questions together in their own separate category. Therefore, after this, no follow-up questions were included in the echoing category.

New question. I also came across several occasions when the instructor introduced a new topic into the conversation. Since these instances brought the conversation to a different topic than that of the previous stream of discussion, I did not want to categorize them as follow-up questions. Therefore, I created a new category to contain them called “New question.”

“Tell me about”. Another category that emerged contained instances in which the instructor prompted the student to begin discussing a particular subject by saying to the student, “Tell me about [subject].”

Refinement of category definitions. Now, I possessed refined definitions of my original questioning categories, in addition to several new questioning categories. In order to see more of the instructor questioning landscape, I continued coding the Student E video with these five categories: (a) Echoing, (b) “Say more about that,” (c) Follow-up question, (d) New question, and (e) “Tell me about.”

As I watched and re-watched the Student E video to code the questioning techniques, I thought about each instance I had categorized, considering whether or not it truly fit into its category. I was thereby forced to decide what belonged and

didn't belong in each category, and my category definitions were slowly refined as I gained a clearer understanding of which instances belonged under which categories.

Though I did not continue investigating categories beyond Echoing for my main research question, the time spent refining all the categories was helpful for the following reasons:

- I understood what did not belong in the “echoing” category because it belonged to another category.
- By virtue of the former, I understood what *did* belong in the “echoing” category.
- I added instances of various techniques that I had initially missed; this included instances of echoing.

From “Echoing” to “Revoicing”. As part of the literature review concurrent with this analysis, I learned that the revoicing category existed and could be applied to my research topic. Therefore, for the purposes of this project, both “echoing” and “revoicing” should be considered to refer to the same phenomenon. However, for ease of communication, the rest of this work will refer only to “revoicing.”

Main Analysis

After completing the above preliminary analysis, I narrowed my focus to one specific technique, in accordance with step two of the video research protocol from Engle et al. (2007).

Development of Final Coding Scheme

In order to keep the focus of my project narrow enough for the work to be feasible, I decided to revisit only the instances of revoicing. From this point on, I

would not complete any further analysis of the other types of questioning techniques. My first task was to see what further information could be known about each revoicing instance in the Student E video. As I went back and watched each instance of revoicing that I had previously logged, I added annotations to each time stamp with information regarding (a) the student's response to the instance and (b) the instructor's follow-up to the student response.

A new coding scheme. As I added these annotations, I began to notice patterns in the ways that the student responded to the revoicing instances. For example, in several cases, the student responded to the revoicing by elaborating on what he had previously said. At other times, he confirmed what he had said by a simple "Yeah." I also began to notice that certain revoicing instances seemed to function similarly to each other. For example, some instances seemed to prompt these similar student responses.

After taking notes on several of the instances, I had a rough idea of which coding categories might now be useful. For each revoicing instance, I created categories for both (a) the function of the instance and (b) the student response to the instance.

Coding scheme refinement. Next, I began to add codes to the revoicing instances corresponding to each category described below.

Function codes. When I began coding the functions of the revoicing instances, I noticed that some instances served to summarize what the student had just been saying. Other instances seemed to prompt the student to take certain actions, such as elaborating on what he had previously stated, or evaluating his previous ideas. Therefore, I created two groups of function codes along these lines, as shown in Table 2.

After coding several instances with the scheme shown above, I soon realized

Table 2

Revoicing Function Codes - Initial Version

Code family	Sub-code with modifiers
Prompt student to...	Continue to consider and discuss the idea(s) at hand
	Evaluate merit of previous idea
	Focus on one aspect of student's idea/words
Summarize to...	Continue similar train of thought
	Start new train of thought

that the sub-codes from Table 2 belonged with my list of student response codes rather than function codes. At this point, I condensed my function codes down to the two previous code families: prompt and summary.

After coding several more instances with just the two function codes, I realized that the revoicing instances could not easily be categorized as either prompt or summary. Many instances seemed to function in both ways. Therefore, I discontinued the use of function codes to categorize my data and instead used the ideas of “prompt” and “summary”—and a third function that later arose, “segue”—to create a definition of the function of revoicing (see *Results—Conversational Functions*).

Response codes. Thus, my coding scheme morphed into one which noted student responses only. As I categorized various instances by student response, I refined the response categories, as shown in Table 3. For my final analysis, revoicing instances could be assigned one or more student response codes.

Inflection pattern codes. During my exploration of the data, I noticed a phenomenon that has become a central focus of my case study: in certain instances

Table 3

Student Response Codes

Code	Grouping
Confirm. . .	previous ideas
Negate. . .	
Clarify. . .	
Elaborate on. . .	
Question. . .	
Continue with. . .	
Propose. . .	new idea
Wait for. . .	instructor
Accept. . .	instructor idea
Discuss. . .	
Reject. . .	instructor wording

of revoicing, the instructor employed a rising vocal inflection that made the instance sound like a question. In other instances, the instructor's firm or lowering tone of voice made the instance sound like a statement. Therefore, I called these inflection types interrogative and declarative, respectively.

When these categories emerged, I became curious to know if students responded in different ways to these two instructor inflection patterns, so I decided to compare the student responses for each type of inflection. Therefore, I categorized each revoicing instance as (a) interrogative, (b) declarative, or (c) ambiguous.

The third category, ambiguous, was created for several instances that could not easily be identified as either interrogative or declarative. These instances were often—though not always—part of the lead-up to a follow-up question asked right after the revoicing was over.

Component codes. As a last-minute addition, I decided to code all revoicing instances by their components, most of which are described in *What Is Revoicing?*. The four component codes I used in BORIS were:

1. “Acknowledgment,”
2. “Discourse Marker,”
3. “Reformulation,” and
4. “Repetition.”

The first code, Acknowledgment, indicated that the instructor said something like “Okay” at the beginning of the instance. This was a component not mentioned in the literature but found frequently in the Student E video. One could argue whether or not this acknowledgment is actually part of the revoicing occurrence; this discussion will not be attempted here. Whether or not it should be counted as part of the revoicing itself, I marked its presence since it occurred a number of times in the video.

The second code, Discourse Marker, indicated that the instructor said “so” near the beginning of the instance. The third and fourth codes, Reformulation and Repetition, were chosen to indicate whether the revoicing instance was rephrased from what the student said (Reformulation) or verbatim (Repetition). Either Reformulation or Repetition was chosen; both could not be chosen at the same time for one instance.

The instances of revoicing in the Student E video did not contain any attributions, concomitant verbs, or requests for validation (see *What Is Revoicing?*). Therefore, these components did not need to have codes.

Follow-up codes. Another last-minute addition to my coding was a group of modifiers to indicate follow-up, allowing me to mark some instances that were followed soon after or directly after by the instructor saying something else. These

categories were (a) lead-up to additional revoicing, (b) lead-up to new question, and (c) lead-up to follow-up question or statement. I did not give every revoicing instance a follow-up code. These codes were used only when the revoicing instance and the follow-up seemed to be directly linked in some way.

Final coding scheme. The computer program BORIS allows “modifiers” to be added to time stamped instances. Instances can have several modifiers, each belonging to a different category. For my final stage of data coding, I categorized the data by adding modifiers for (a) inflection type, (b) student response type, (c) revoicing components, and (d) follow-up, as described in the above sections. Each instance was allowed up to three different student response types; I labelled these “primary,” “secondary,” and “tertiary”.

Research Questions

Three research questions emerged during the main analysis.

Research question 1. The first research question addresses the conversational functions of the revoicing technique in this particular context:

In a discussion-based physics oral exam, what conversational functions are fulfilled by the revoicing technique?

Research question 2. The second research question addresses the overall use of the revoicing technique in this particular context:

In a discussion-based physics oral exam, what is the overall landscape of the instructor revoicing technique, in terms of revoicing components, timing, inflection type, and response type?

Research question 3. Not only did a broad overview of the revoicing technique seem useful, but it also seemed desirable to measure the effects of the revoicing technique in some way. With the emergence of inflection type categories, comparing the student response types with respect to inflection type seemed like a reasonable way to do this. Thus, the third research question addresses the effects of revoicing inflection type on student response:

For a case study student in a discussion-based physics oral exam, how does the declarative, interrogative, or ambiguous character of a revoicing instance affect the student's response?

Method of Answering Research Questions 2 and 3

After developing the final coding scheme, codes were applied to the Student E video as modifiers in the BORIS program. Next, the coded time stamps were exported to a CSV file, to be analyzed further in Microsoft Excel (2016).

The CSV file from which I examined the exported data contained one row for each revoicing instance that I had logged while watching the video. This row included, among other things, a time stamp for each instance and cells containing the modifiers I added to each instance in BORIS. Since the modifiers were located in individual cells associated with each row, I was able to use the spreadsheet “filter” feature to count up instances with certain characteristics. For example, if I wanted to count the number of instances of interrogative revoicing, I filtered the Modifier 1 column. All other instances would temporarily disappear, with only the rows containing “interrogative” in the Modifier 1 column remaining.

Additionally, I used Excel formulas to count instances with certain characteristics. For example, I used formulas to count how many instances contained certain sets of student responses. In several cases, I created formulas to

count how many revoicing instances had the same two characteristics (for example, the same inflection type and the same student responses).

Using these two methods, I was able to examine various groups of revoicing instances and gain a broad understanding of the use of revoicing in the oral exam interview context, in addition to learning how instructor inflection type affected the likelihood of certain student responses for the Student E case study.

Student Engagement Level

In order to address the third research question, one final portion of analysis needed to be done. Student responses needed to be characterized by level of student engagement in order to analyze the effects of instructor inflection.

A pertinent excerpt. Figure 1 shows transcript from the Student E video that demonstrates a key distinction in the response types for revoicing. In the excerpt, revoicing occurs in lines 3, 7, and 11. The student responses are found in lines 4, 8 and 10, and 12, respectively. The first two revoicing instances illustrate how student responses can be distinguished by the level of student engagement they encourage.

Instance One. In the first instance of revoicing (line 3), the instructor repeats the student's idea that fusing two hydrogen atoms together results in extra mass being left over. In this instance, the instructor says, "Some extra amu. . ." with an ambiguous inflection type, and the student responds (line 4) by confirming his previous idea, saying, "Yeah. . ." However, the student does not take his response any further than a simple confirmation of his previous idea.

Instance Two. The second instance of revoicing (line 7) contains an interrogative revoicing of the student's idea that the extra mass could be diffused in some way. Here, the instructor says, "Just—rand—mass scattered around?" The

Figure 1. Student E Excerpt

Line	<i>Speaker</i>
1	<i>Instructor:</i> How does hydrogen turn into helium?
2	<i>Student E:</i> Uh, you can't really... I guess if you... I'm not sure if you can fuse two hydrogen together to make helium, but... <i>[gestures]</i> ... you'd still have a little bit leftover energy from that, 'cause I believe that hydrogen's like 1.008 or something like that, or 04; but anyways, when you take two times hydrogen you still have about like four thousandths of a amu left. There's still some energy left there, so...
3	<i>Instructor:</i> Some extra amu...
4	<i>Student E:</i> Yeah...
5	<i>Instructor:</i> Oh, no. What happens?
6	<i>Student E:</i> It could be diffused, I guess.
7	<i>Instructor:</i> Just—rand—mass scattered around?
8	<i>Student E:</i> Um... <i>[shakes head]</i> no idea.
9	<i>Instructor:</i> Okay.
10	<i>Student E:</i> I guess it's... mm... it could be put off as energy.
11	<i>Instructor:</i> So, you get some hydrogens together, we lose some mass, and it turns into energy?
12	<i>Student E:</i> I mean, it doesn't sound right, but I... I don't know what goes on in there.
13	<i>Instructor:</i> Okay. K. <i>[Instructor starts new conversation thread]</i>

student responds (lines 8, 10) by saying that he has “no idea,” and that he “[guesses]... it could be put off as energy.” On this occasion, rather than simply confirming his previous idea, the student responds by questioning his previous idea (“no idea”) and proposing a new idea (“it could be put off as energy”).

Defining student engagement level. In instance one, the student's response to the revoicing instance is simple and brief. It does not go beyond a simple confirmation of his previous ideas.

This instance and others like it can be called “low engagement.” In revoicing instances with a low engagement response, the student does not engage with his

previous ideas either at all or beyond a simple affirmation. Therefore, the following student responses qualify as low engagement:

- “Confirm previous ideas,”
- “Wait for instructor to speak more,” or
- a combination of both “Confirm” and “Wait.”

On the other hand, in instance two, the student’s response (questioning previous ideas, proposing new idea) indicates further engagement with his previous ideas. That response and all other combinations of responses besides those listed above can be called “high engagement” (see Table 3 for the list of individual student responses and Table 4 for a list of all the response combinations that occurred in the Student E video).

Thus, responses for each inflection type were categorized by student engagement level. Now, the student engagement level for each inflection type could be compared (see *Results—Effect of Inflection Type on Student Response*).

Results

Below, I will discuss the conversational functions of revoicing, give a general profile of the technique as seen in the Student E interview, and examine the variations in student engagement level with inflection type.

Conversational Functions

As I noted in *Main Analysis—Development of Final Coding Scheme—Coding Scheme Refinement—Function Codes*, revoicing instances served several functions in the conversation. Some instances seemed to have more than one function, and some only one. Other instances were difficult to categorize. Thus, I did not attempt to take the Conversational Function analysis any further than previously described.

Claim. However, the following can still be claimed in response to research question 1:

In a physics oral examination context, revoicing can serve as a prompt to the student, a summary of parts of the conversation, and/or a segue to the next part of the conversation.

General Profile

In response to research question 2, the following sections describe the overall landscape of revoicing in the Student E video. In the forty-five minute interview with Student E, about forty-two minutes were spent discussing the content of the interview. The other three minutes of the interview were spent discussing logistics of class assignments. A total of forty-eight revoicing instances occurred during the interview.

Revoicing components. Figures 2 and 3 show the distribution of instances with various components for each inflection type and for all the instances combined. Out of all the revoicing instances, 62.5% (30/48) contained only a reformulation or repetition with no additional components, 8.3% (4/48) contained an acknowledgment, 22.9% (11/48) contained an inference marker, and 6.3% (3/48) contained both an acknowledgment and an inference marker. None of the revoicing instances in the Student E video contained an attribution, a concomitant verb, or a validation request.

Grouping the instances by inflection type reveals the following distributions. For declarative revoicing, 54.2% (13/24) contained only a reformulation or repetition with no additional components, 12.5% (3/24) contained an acknowledgment, 25.0% (6/24) contained an inference marker, and 8.3% (2/24) contained both an acknowledgment and an inference marker. For interrogative

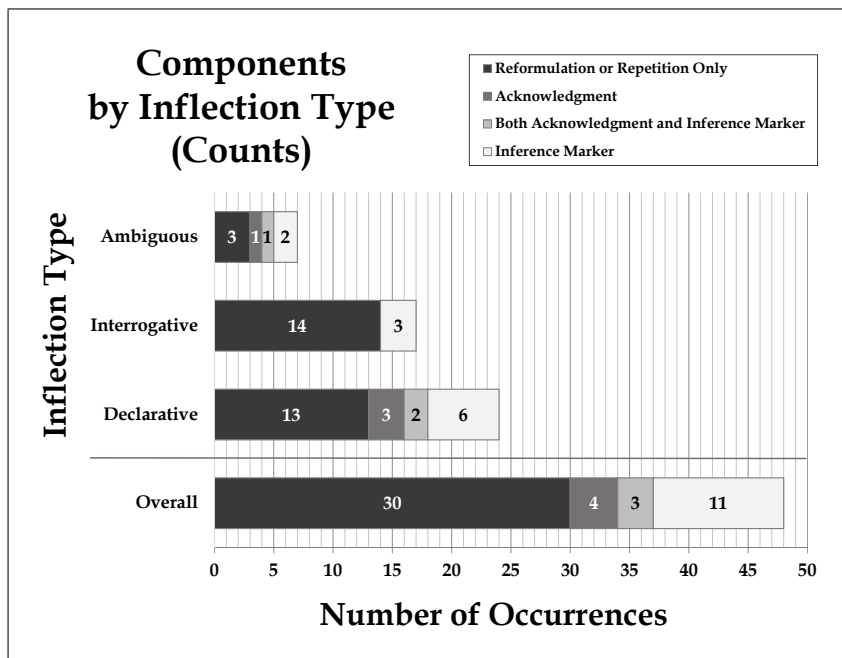


Figure 2. Revoicing Components Present in Student E Video (Number)

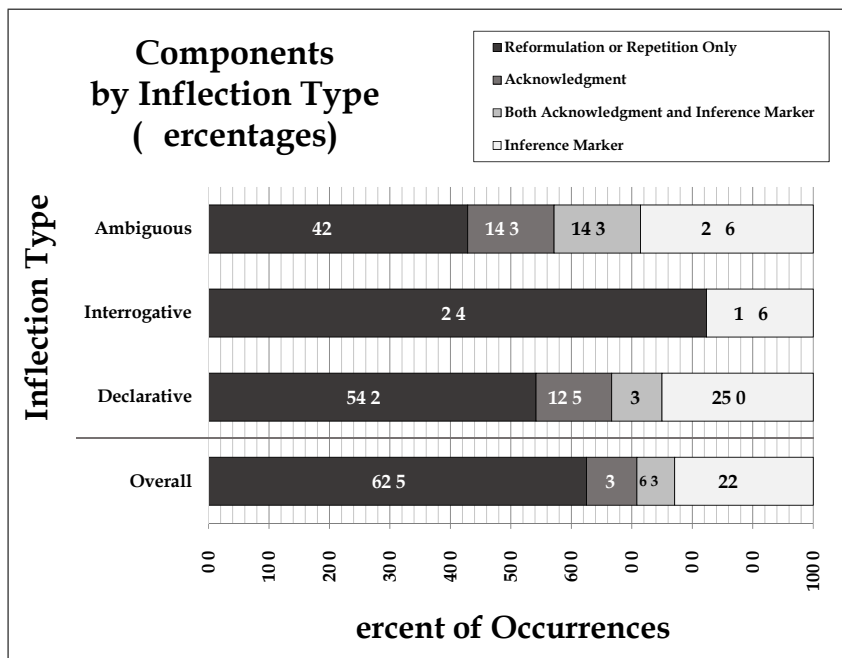


Figure 3. Revoicing Components Present in Student E Video (Percentage)

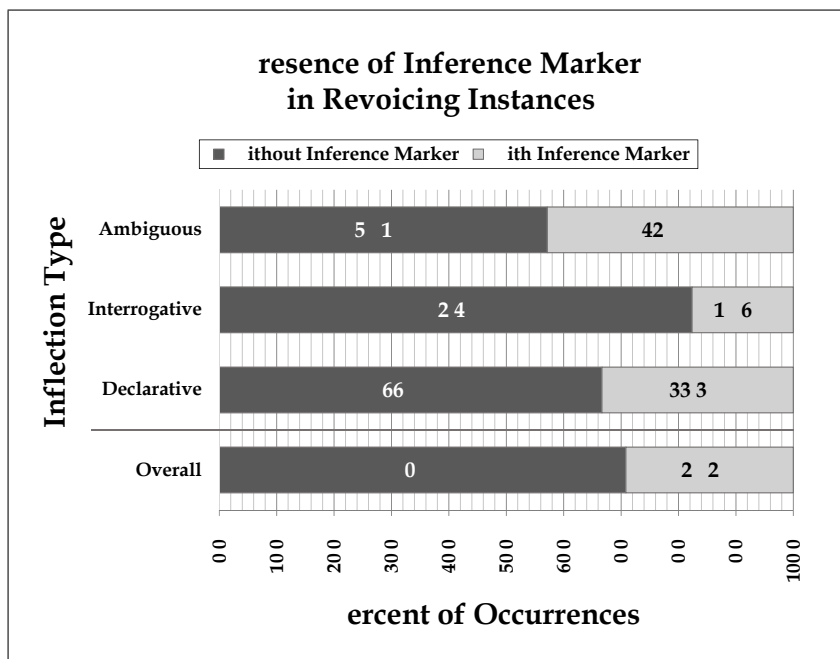


Figure 4. Presence of Inference Marker in Revoicing Instances

revoicing, 82.4% (14/17) contained only a reformulation or repetition with no additional components, no instances contained an acknowledgment, 17.6% (3/17) contained an inference marker, and no instances contained both an acknowledgment and an inference marker. For ambiguous revoicing, 42.9% (3/7) contained only a reformulation or repetition with no additional components, 14.3% (1/7) contained an acknowledgment, 28.6% (2/7) contained an inference marker, and 14.3% (1/7) contained both an acknowledgment and an inference marker.

Notably, no interrogative revoicing instances contained an acknowledgment. Also, as Figure 3 shows, 82.4% (14/17) of interrogative instances contained only the reformulation or repetition, whereas just 54.2% (13/24) of declarative instances and 42.9% (3/7) of ambiguous instances contained only the reformulation or repetition.

Presence of Inference Marker. Figure 4 creates two groups from the previous four, in order to separate the instances by their inclusion of an inference

marker. “Without Inference Marker” contains all instances from the previous “Reformulation or Repetition Only” and “Acknowledgment,” while “With Inference Marker” contains all instances from the previous “Both Acknowledgment and Inference Marker” and “Inference Marker.”

These new groupings show that just 66.7% of declarative instances and 57.1% of ambiguous instances lack an inference marker. On the other hand, 82.4% of interrogative instances lack an inference marker. Thus, interrogative instances were less likely to contain an inference marker than declarative or ambiguous instances, as shown in Figure 4.

Time distribution. During the forty-two minutes of content discussion, the Instructor revoiced the student forty-eight times, an average of over one revoicing instance per minute of the interview. A timeline of all the revoicing events in the forty-five minute video (Figure 5) demonstrates that revoicing instances were fairly evenly spread through time, rather than concentrated in one part of the interview much more than another.

Also notable in Figure 5 are a number of instances with multiple revoicing events very close to each other in time. This phenomenon occurred when the instructor revoiced the student several times in quick succession. (In some of these cases, the revoicing instances can be difficult to visually differentiate on the graph due to the close time proximity. These are labeled with arrows on the graph.) During several of these sequences, the instructor did a series of short revoicings, receiving short responses from the student each time.

Inflection type. Of the forty-eight revoicing instances, twenty-four (50.0%) were declarative, seventeen (35.4%) were interrogative, and seven (14.6%) were ambiguous. Thus, half the revoicing instances in the interview were the declarative type, and most of the others were interrogative.

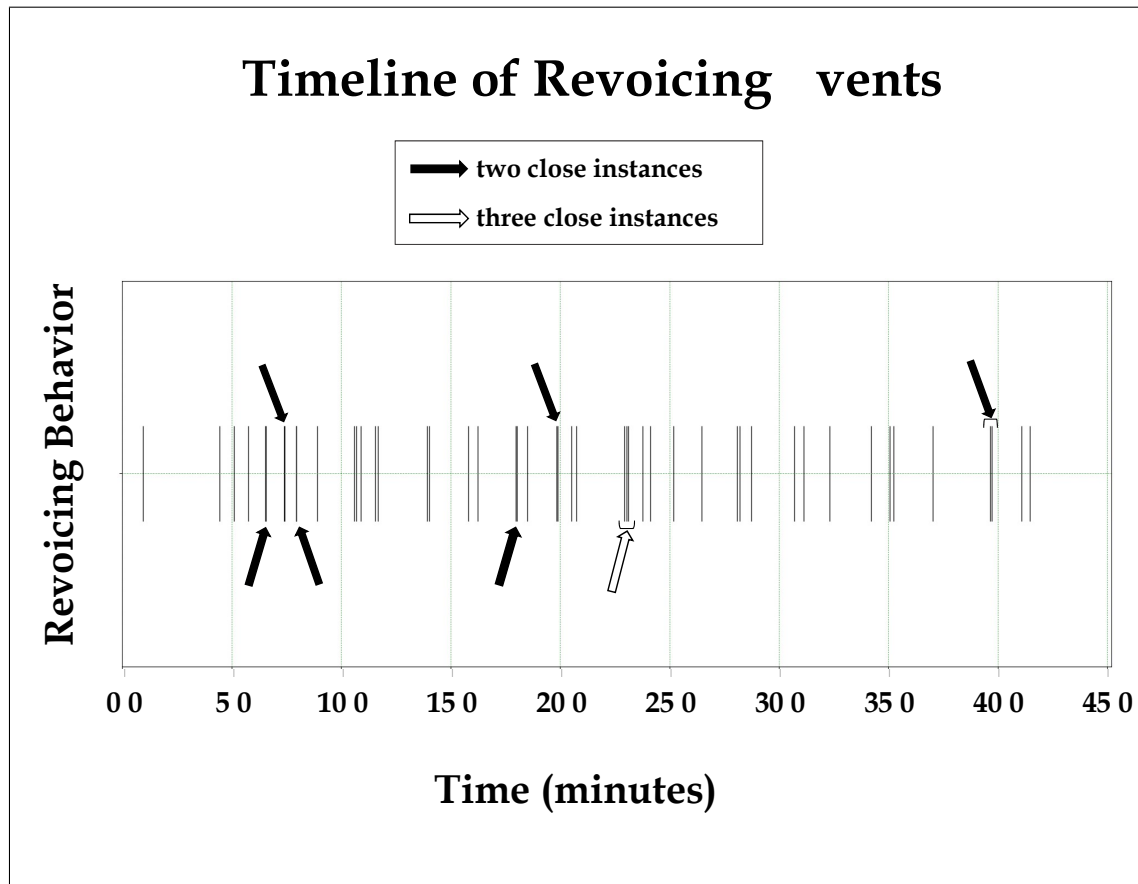


Figure 5. Timeline of Revoicing Events

Figure 6 shows the time distribution of revoicing instances by inflection type. As the timeline shows, both interrogative and declarative revoicing occurred in the beginning, middle, and end of the interview, with the exception of three five-minute segments. From 0.0 to 5.0 minutes and from 40.0 to 45.0 minutes, only declarative revoicing occurred, and from 30.0 to 35.0 minutes, only ambiguous revoicing occurred. Both declarative and interrogative revoicing occurred in every five minute segment between 5.0 and 30.0 minutes and between 35.0 and 40.0 minutes.

Ambiguous revoicing, on the other hand, occurred only twice in the first fifteen minutes of the interview and was not present again until much later, when it occurred five times between 30.0 and 36.0 minutes. No other type of revoicing

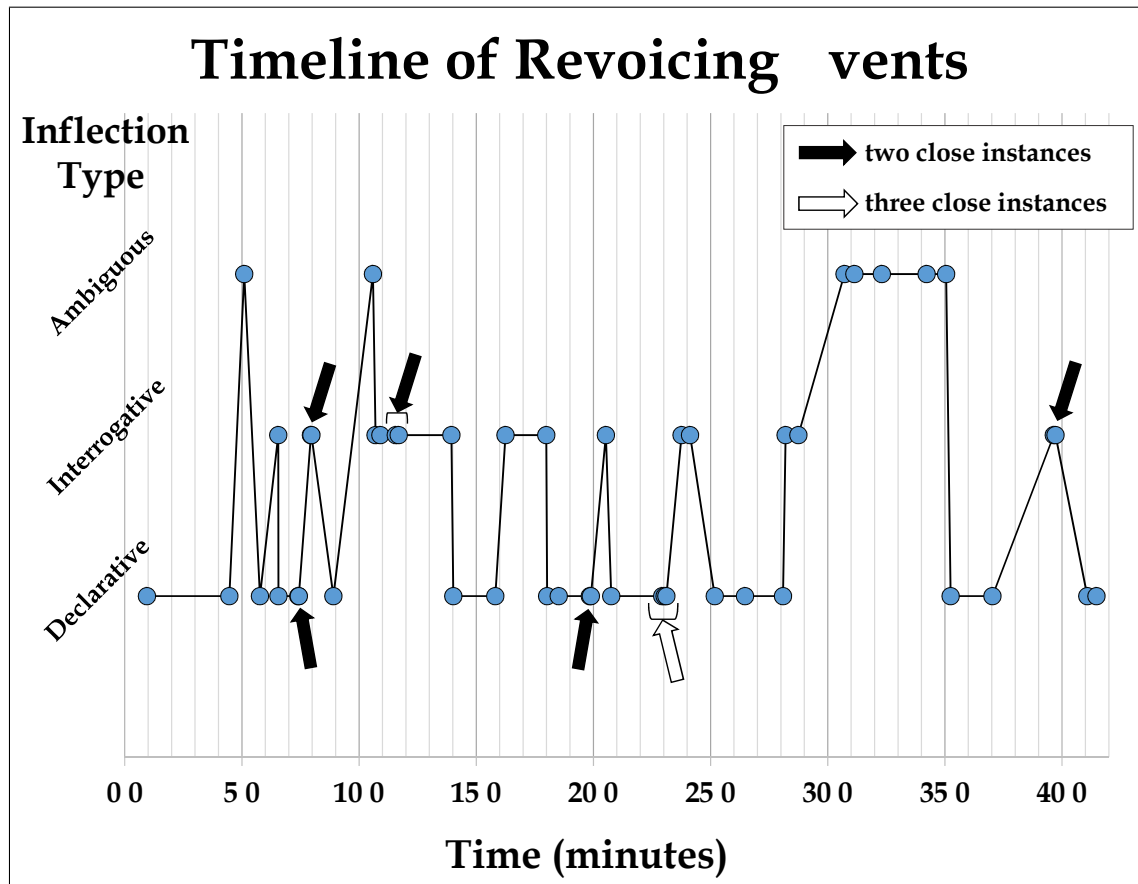


Figure 6. Timeline of Revoicing Events by Inflection Type

occurred during that six minute period.

Response types. If we count each individual response without considering their multiple-response groupings, the data contained a total of sixty-eight different response occurrences. Figure 7 shows the distribution of these sixty-eight occurrences among the response types.

Table 4 shows the distribution of student response types present in the video, with the responses for each revoicing instance grouped together. Twenty-nine (60.4%) of the forty-eight revoicing instances had only one student response type, eighteen instances (37.5%) had two response types, and one instance (2.1%) had three response types.

Table 4

Student Response Types

Primary Response	Secondary Response	Tertiary Response	Count (% of Grand Total)
Confirm previous ideas			19 (39.6)
Elaborate on previous ideas			3 (6.25)
Wait for instructor to speak more			2 (4.2)
Clarify previous ideas			2 (4.2)
Question previous ideas			1 (2.1)
Reject instructor wording			1 (2.1)
Continue with previous ideas			1 (2.1)
		Total	29 (60.4)
Confirm previous ideas	Elaborate on previous ideas		5 (10.4)
Confirm previous ideas	Wait for instructor to speak more		5 (10.4)
Accept instructor idea	Discuss instructor idea		3 (6.25)
Confirm previous ideas	Clarify previous ideas		2* (4.2)
Reject instructor wording	Clarify previous ideas		1 (2.1)
Negate previous ideas	Elaborate on previous ideas		1 (2.1)
Question previous ideas	Propose new idea		1 (2.1)
		Total	18 (37.5)
Negate previous ideas	Clarify previous ideas	Continue with previous ideas	1 (2.1)
		Total	1 (2.1)
		Grand Total	48 (100)

*This "2" includes an instance which contains "clarify" as the primary response and "confirm" as the secondary response.

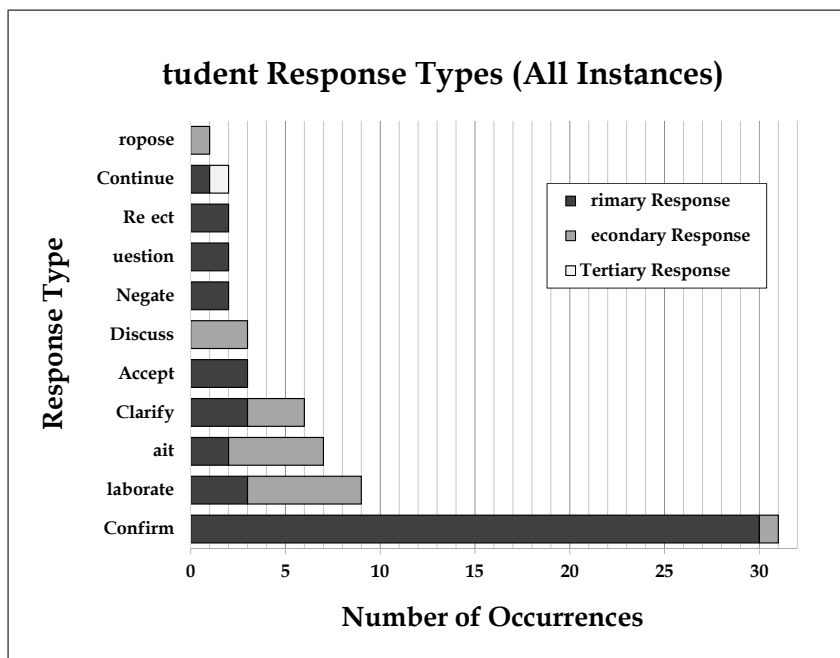


Figure 7. Student Response Types for All Instances

As shown in Table 4, “Confirm previous ideas” was by far the most common student response to instructor revoicing at 39.6% of all responses, followed by “Confirm / Elaborate” and “Confirm / Wait” (both at 10.4%).

“Confirm previous ideas”. Figure 7 reveals that, counted individually, the most common response type was “Confirm previous ideas,” with thirty-one total occurrences. All but one of these occurrences were the primary response for an instance.

Nineteen (or 63.3%) of the thirty “Confirm” primary response instances occurred by themselves, with no secondary response. These nineteen “Confirm” responses were all relatively short confirmations such as “Yeah,” or “Mhm” (the longest confirmation was “Yeah; I’d assume so”). Each of the nineteen “Confirm”-only instances led directly to an instructor follow-up: fourteen of the nineteen (73.7%) led to a follow-up question or statement, four (21.1%) led to

another revoicing instance, and one (5.3%) led to a new question.

Five (16.1%) out of the thirty-one total “Confirm” instances occurred with a secondary response of “Elaborate on previous ideas,” and five occurred with a secondary response of “Wait for instructor to speak more.” Finally, “Confirm” appeared twice in a pair with “Clarify previous ideas,” once as the primary response and once as the secondary response.

“Elaborate on previous ideas,” “Wait for instructor to speak more,” and “Clarify previous ideas”. After “Confirm,” the next most common response types were “Elaborate on previous ideas,” “Wait for instructor to speak more,” and “Clarify previous ideas,” with nine, seven, and six occurrences, respectively. In contrast to “Confirm previous ideas,” however, a majority of the “Elaborate” and “Wait” instances and half the “Clarify” instances were secondary responses, rather than primary responses, as shown in Figure 7.

As shown by Table 4, “Elaborate” appeared as the secondary response with “Confirm” (five instances) and “Negate” (one instance). “Wait” appeared as the secondary response with “Confirm” (five instances). “Clarify” appeared as the secondary response with “Confirm” (one instance), “Reject instructor wording” (one instance), and “Negate” (one instance), the latter with “Continue” as a tertiary response.

All three of the “Elaborate” primary responses, both of the “Wait” primary responses, and two of the “Clarify” primary responses appear by themselves as the sole responses to revoicing instances.

“Accept instructor idea” and “Discuss instructor idea”. Figure 7 demonstrates that “Accept instructor idea” and “Discuss instructor idea” had three occurrences each. All three “Accept” occurrences were primary responses, and all three “Discuss” occurrences were secondary responses. Table 4 shows that these

“Accept” and “Discuss” occurrences compose the response groupings for three separate revoicing instances.

These instances occurred when the instructor stated an idea, the student repeated part of the idea, and the instructor revoiced the student’s repetition. After this revoicing, the student accepted the idea and discussed it.

Neither “Accept” nor “Discuss” appeared by itself or in an alternative pairing.

“Negate previous ideas,” “Question previous ideas,” and “Reject instructor wording”. “Negate previous ideas,” “Question previous ideas,” and “Reject instructor wording” each occur twice as the primary response to a revoicing instance.

Referring back to Table 4, “Question” and “Reject” each appear by themselves once and once as part of a response pairing. “Negate” never appears by itself, but appears once as part of a response pairing (with “Elaborate” as its secondary response) and once as part of a response triad (with both “Clarify” and “Continue”).

“Continue with previous ideas” and “Propose new idea”.

“Continue with previous ideas” occurs twice, once as a primary response and once as a tertiary response. Finally, “Propose new idea” occurs once as a secondary response (with “Question previous ideas” as its primary response).

Effect of Inflection Type on Student Response

In response to research question 3, the following section will describe how student responses and thus student engagement varied with respect to the inflection types of the revoicing instances.

Response types by inflection type. Table 5 shows the number of occurrences of each student response type with respect to revoicing inflection type. A cursory overview reveals that half the total instances (12/24) of declarative

Table 5

Student Responses by Inflection Type

Primary	Response*		Count (% of Grand Total)		
	Secondary	Tertiary	Declarative	Interrogative	Ambiguous
Confirm	None	None	12 (50.0)	4 (23.5)	3 (42.9)
Elaborate	None	None	0 (0.0)	2 (11.8)	1 (14.3)
Wait	None	None	0 (0.0)	0 (0.0)	2 (28.6)
Clarify	None	None	1 (4.2)	1 (5.9)	0 (0.0)
Question	None	None	0 (0.0)	1 (5.9)	0 (0.0)
Reject	None	None	1 (4.2)	0 (0.0)	0 (0.0)
Continue	None	None	0 (0.0)	0 (0.0)	1 (14.3)
		Total	14 (58.3)	8 (47.1)	7 (100.0)
Confirm	Elaborate	None	3 (12.5)	2 (11.8)	0 (0.0)
Confirm	Wait	None	4 (16.7)	1 (5.9)	0 (0.0)
Accept	Discuss	None	2 (8.3)	1 (5.9)	0 (0.0)
Confirm	Clarify	None	0 (0.0)	1 (5.9)	0 (0.0)
Clarify	Confirm	None	1 (4.2)	0 (0.0)	0 (0.0)
Reject	Clarify	None	0 (0.0)	1 (5.9)	0 (0.0)
Negate	Elaborate	None	0 (0.0)	1 (5.9)	0 (0.0)
Question	Propose	None	0 (0.0)	1 (5.9)	0 (0.0)
		Total	10 (41.7)	8 (47.1)	0 (0.0)
Negate	Clarify	Continue	0 (0.0)	1 (5.9)	0 (0.0)
		Total	0 (0.0)	1 (5.9)	0 (0.0)
		Grand Total	24 (100.0)	17 (100.0)	7 (100.0)

*Full titles of response types can be found in Table 4.

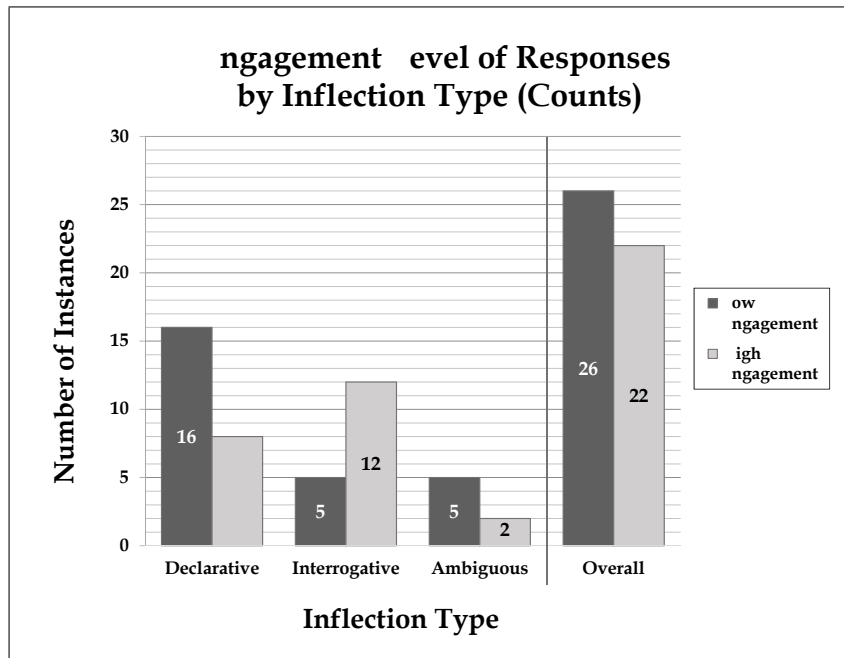


Figure 8. Student Engagement Level, by Revoicing Inflection Type (Counts)

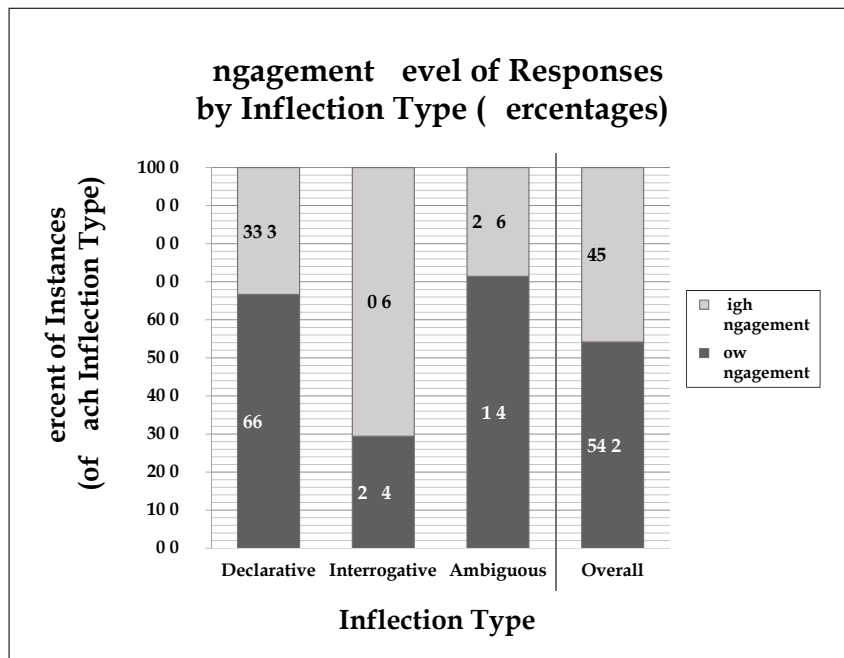


Figure 9. Student Engagement Level, by Revoicing Inflection Type (Percentages)

revoicing concluded with a response of only “Confirm previous ideas,” compared with only four of seventeen instances of interrogative revoicing.

Response types by engagement level. Figures 8 and 9 group the responses for each inflection type by student engagement level, revealing the relationship between the inflection type of the revoicing instances and the student engagement level of their responses.

Out of all the revoicing instances, 54.2% (26/48) were low engagement, while 45.8% (22/48) were high engagement. However, when the instances were grouped by inflection type, these percentages changed drastically. Of revoicing instances with declarative inflection, only 33.3% (8/24) had high engagement responses, while 66.7% (16/24) had low engagement responses. Percentages for ambiguous inflection mirrored those for declarative inflection, with 28.6% (2/7) high engagement responses and 71.4% (5/7) low engagement responses. Of revoicing instances with interrogative inflection, however, 70.6% (12/17) had high engagement responses, while 29.4% (5/17) had low engagement responses.

Claim. Upon comparing the set of interrogative revoicing instances with the sets of declarative and ambiguous revoicing instances, a clear pattern can be seen with respect to the level of student engagement in response to revoicing with various inflection types. Therefore, in response to research question 3 (see *Main Analysis—Research Questions—Research question 3*), I claim the following:

In this case study, when a physics instructor revoiced a student in a discussion-based oral exam setting, interrogative inflection was more likely to result in responses reflecting a high engagement level, whereas declarative and ambiguous inflections were more likely to result in responses reflecting a low engagement level.

More research is needed to determine if this pattern holds for other students in

this context.

Discussion

This case study reveals revoicing can be a versatile strategy for an instructor. Other research (diSessa et al., 2016; O'Connor & Michaels, 1993; Yifat & Zadunaisky-Ehrlich, 2008) has demonstrated revoicing in a variety of contexts. Those cases, combined with the results of this project, demonstrate the following:

1. Revoicing can be a versatile strategy for a variety of contexts, such as large groups, small groups, and one-on-one.
2. Instructors have a variety of options for how to use the revoicing technique. As described in *What Is Revoicing?*, revoicing can contain a number of components. However, most of these components are optional, with the exception of the reformulation or repetition. Thus, the inclusion or exclusion of various components in an instance of revoicing could be a way to affect the results of the technique.
3. As this case study revealed, vocal inflection can also impact the student response to the revoicing technique. Therefore, vocal inflection is another tool that instructors can use to create an impact on the conversation when they choose to use the revoicing technique.
4. Students respond to revoicing in a variety of ways. Some of these responses involve a simple confirmation only. However, others involve more thought and engagement, such as “Negate previous ideas.” Since, as this study has shown, characteristics about the revoicing instance can impact the student responses, instructors could choose to use revoicing in particular moments when they want the student to respond by taking a certain action, such as rethinking their previous ideas, for example.

Implications for Physics Education

This study reveals that revoicing can be a versatile, productive strategy for physics educators. Revoicing can further both pedagogical and social goals.

Pedagogical goals. In the context of O'Connor and Michaels (1993), a teacher rewords what a student says to make it “more recognizable to the wider world” in the context of a classroom, where “it is considered important to link students’ experiences and inventions with the conventional knowledge categories of the wider world” (O'Connor & Michaels, 1993, p. 326). In a physics education context, it seems plausible that an instructor might reword something a student says to make it more understandable in a science context. In the Student E video, sometimes the instructor slightly altered what the student was saying, rewording it in a way comparable to that described by O'Connor and Michaels. It is possible that the instructor did this for the reasons described, to benefit the student being interviewed, since no other students were present.

In addition to helping students situate their own thinking in a science context, revoicing could also be a tool to prompt students to engage with ideas presented in the conversation. In the Student E case study, though many revoicing instances did not encourage a high level of student engagement, many other revoicing instances did—especially those of interrogative inflection. Therefore, revoicing—interrogative in particular—shows promise as a tool to encourage students to continue engaging with ideas in a scientific conversation, rather than stopping after one contribution.

Social goals. In addition to pedagogical goals, revoicing could have social implications for the instructor-student relationship. For example, O'Connor and Michaels (1993) discuss using revoicing in order to manage so-called “participant frameworks.” Participant frameworks describe the way participants in a

conversation align themselves or others in relation to one another based on the content of the conversation. One participant can use words to create a particular framework, and another participant can enter that framework or choose to create another one (O'Connor & Michaels, 1993).

The “participant frameworks” concept may have bearing on this study, insofar as the frameworks set and used by the instructor and the student may have implications for the intention of the instructor in using revoicing. However, knowing the instructor’s intention for revoicing is not possible within the limitations of this study. The goal of this study is to understand the mechanics of revoicing interactions and the immediate responses of the student to them rather than investigating any social goals for revoicing. This study has attempted to explicate the surface-level features and course content implications of the revoicing technique without attempting to make inferences regarding the relationship between the instructor and the student and their roles in the conversation.

Contrasts to Previous Research

This project contrasts with previous research in several ways.

Revoicing Components. One area of contrast lies in the revoicing components found in the instances from the Student E video. Though revoicing instances from previous research often included verbal attributions and sometimes contained requests for validation (diSessa et al., 2016; O'Connor & Michaels, 1993; Yifat & Zadunaisky-Ehrlich, 2008), the revoicing instances in the Student E video contained neither of these components.

This could be due to differences in the contexts of the conversations being researched or due to the interviewer’s or instructor’s habits of conversation. More research would need to be done to determine which of the two is the more likely

reason and the impact on revoicing outcomes, if any, of the inclusion and exclusion of various components.

Approach to Main Analysis. Another contrast to other research projects comes from the approach to analysis that I took.

According to Engle, Conant, and Greeno, “because of the richness of video data, the problem is not usually of having something to say, but of choosing among the many things that one could say and fashioning them into a coherent account” (2007, p. 248). Accordingly, for this project I attempted to specify my objectives as clearly and simply as possible, in order to reach valuable conclusions regarding the phenomenon that I observed. I did not attempt to provide a thorough analysis of every single thing that could be seen from the video. Rather, my approach to this research project was to isolate a phenomenon of interest (revoicing), create a picture of what occurred during the phenomenon of interest (components, student responses), then isolate one specific facet of that phenomenon (inflection type) to highlight via comparison.

Others (e.g., Engle et al., 2007; O’Connor & Michaels, 1993) took a broader approach to describing their phenomenon of interest, focusing their analysis on comprehensively describing only one or two examples instead of isolating one facet of the phenomenon. Contrastingly, I chose to have a narrow focus, which limited the types of conclusions that could be drawn in this study. However, this was intended to make my conclusions stronger by ensuring that they were backed by clear numerical evidence, such as could be seen in the answer to research question 3.

Limitations of this Study

This project has a number of limitations, which are detailed below.

Numerical scope. One limitation to this study comes from the scope of the investigation, which was limited by time and resources. Rather than investigating a larger pool of data and comparing results between students, this study focused on one individual case study. Though the conclusions to this work would be stronger if supported by additional evidence, this case study does provide a foundation on which to base further research (see *Future Work*).

Video format. The format of the video data provides another limitation to the study. The video showed an outsider's view of only the oral exam interview between the instructor and the student. The data did not demonstrate what the student or instructor thought about their interactions. Therefore, the types of conclusions that could be drawn regarding unobservable "effects on students of participating in or observing a revoicing sequence" (O'Connor & Michaels, 1993, p. 331) were limited, because no conclusions were drawn about things that could not be directly observed from the data.

Context. Another limitation of this study comes from the specific context of the video data. Since the project used video of a specific context, a one-on-one undergraduate physics oral exam interview, the results may not apply to other contexts, such as whole-class or small group discussions, or even one-on-one settings in disciplines other than physics. However, this project does provide information about the mechanics of the revoicing technique that can be contrasted with similar information from other contexts.

Like a classroom setting, the context for this project involves an interaction between an instructor and a student in a learning environment. However, unlike a classroom setting, the context for this project included no additional bystanders interacting with or observing the conversation. Further research is needed to understand the differences of the use of the technique in a one-on-one setting versus

small or large group settings.

Language. Language also brings a limitation to this study, since the data used for this project contains interviews conducted in English but not other languages. This study could be applicable to other languages, but further work would need to be done to see if the same phenomenon occurs in other languages and which aspects are the same or different to this study, especially regarding the components of revoicing and the vocal inflection of the instructor. Since other languages may not have comparable grammar or vocal inflection to the English language, the results of this study should not be extrapolated to other languages without careful thought and good reason.

Conclusion

This project examined the questioning strategies of an undergraduate physics instructor conversing with a student in a one-on-one, discussion-based assessment setting. Exploratory video analysis of eight such interviews (same instructor, different students) revealed that the instructor used several questioning strategies, including follow-up questions, new questions, saying “Say more about that” or “Tell me about. . . ,” and finally, a strategy initially labeled echoing, in which the instructor repeated something said by the student without any extra “question” words. Eventually, this echoing strategy became the sole focus of the project and was found to fit in a larger category called “revoicing.”

A computer program called BORIS allowed revoicing instances to be time stamped and marked with a variety of information. After one case study video was chosen for further analysis, each revoicing instance in the video was time stamped and given codes denoting the instance’s components, inflection type, student response type(s), and instructor follow-up (if applicable). After time stamping and

coding all the revoicing instances in the video, each set of codes was double checked for accuracy.

Next, the time stamps and codes were exported to Microsoft Excel for analysis by grouping. During the Excel analysis, three functions emerged for instructor revoicing in this setting. Revoicing served as a prompt, a summary, and/or a segue. The instructor used three inflection types: declarative, interrogative, and ambiguous. Eleven different student responses emerged, of which the most common was “Confirm previous ideas.” Other responses included—but were not limited to—“Question previous ideas,” “Clarify previous ideas,” and “Negate previous ideas.” On some occasions of revoicing, the student response included more than one response code.

Finally, student responses were grouped by the level of student engagement they reflected (high or low), revealing for the Student E case study a much greater chance of high student engagement when a revoicing instance was interrogative than when a revoicing instance was declarative or ambiguous. Thus, the initial case study reveals that the inflection type of a revoicing instance can affect the student response to the instance. More research is needed to determine if this same pattern holds for other students and other physics education contexts.

Future Work

This study brings up many potential avenues for future research. For example, the Student E case study raises several questions about the instructor revoicing with other students. The most immediate of these, perhaps, is: does the result about more frequent high-engagement responses for interrogative revoicing in contrast to declarative revoicing hold for other students in this same context? Additionally, the Student E video showed several occasions of closely-timed multiple instances of

revoicing. Future research could ask, “Do revoicing instances for other students have patterns in their timing?” Table 5 reveals that the only two occurrences of a solo “Wait for instructor to speak more” response occurred after an ambiguous revoicing instance. Future work could investigate if this occurred for other students in the same context.

This project was completed in a one-on-one discussion-based assessment interview setting. However, how is revoicing used in other physics education contexts, such as classroom discussion, recitation, laboratory class, tutoring, or even a one-on-one oral exam interview that is focused on problem solving rather than conceptual discussion? What are the mechanics (components, inflection type) of the technique in those settings? Future research could compare the student responses to and the effectiveness of the revoicing technique in various physics education contexts.

Finally, a number of other questions related to revoicing could be investigated. Since the data used in this project did not allow insight into the student’s or instructor’s thoughts about the technique, future research could investigate discrepancies between the instructor’s intention for an instance of revoicing and the student’s reception of the technique. Do instructors have other techniques at their disposal with similar effects to revoicing? If so, why do they choose to use revoicing in some instances and not others? What does revoicing achieve that cannot be obtained with other techniques? These questions have yet to be explored. In the meantime, revoicing remains a useful yet flexible conversational tool for educators in physics and many other disciplines.

Acknowledgements

Completion of this project was made possible by the help and support of many. I'd like to publicly thank the following:

- Dr. Thomas Brown, adviser extraordinaire, for his advice and encouragement throughout the years of completing this project and my degree program;
- Dr. Andrew Roberts and Dr. Jorge Méndez, for agreeing to be my committee members and for sharing your thoughts about the project with me;
- PEER collaborative group for help and encouragement throughout the project, in particular Eleanor Sayre for helping me access the data;
- Minnesota State University, Mankato Department of Physics and Astronomy professors and support staff, for providing a safe, encouraging place to learn and grow;
- Union University Department of Physics for providing me with a solid foundation of physics and faith;
- family, for always being there for me;
- friends, including my fellow graduate students, roommates, and church folks;
- Uncle Steve and Aunt Julie, for providing linguistic input and a place for me to crash every now and then;
- dictionary.com and thesaurus.com, for being wonderful resources; and finally
- God, for giving me the insatiable desire to learn and for providing me with opportunities to do so.

To everyone mentioned above and to all others who played a role in my life during the completion of this project, I say a hearty “Thank you!”

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Appendix
Institutional Review Board (IRB) Approval Letter



November 8, 2017

Dear Thomas Brown, PhD:

Re: IRB Proposal entitled "[1154784-1] Investigation of the relationship of middle- and/or upper-level undergraduate physics students to the nature of science through their words, actions, and/or affect in the classroom"

Review Level: Level [I]

Your IRB Proposal has been approved as of November 8, 2017. On behalf of the Minnesota State University, Mankato IRB, we wish you success with your study. Remember that you must seek approval for any changes in your study, its design, funding source, consent process, or any part of the study that may affect participants in the study. Should any of the participants in your study suffer a research-related injury or other harmful outcome, you are required to report them to the Associate Vice-President of Research and Dean of Graduate Studies immediately.

The approval of your study is for one calendar year less a day from the approval date. *[If exempt, remove previous sentence]* When you complete your data collection or should you discontinue your study, you must submit a Closure request (see <http://grad.mnsu.edu/irb/closure.html>). All documents related to this research must be stored for a minimum of three years following the date on your Closure request. Please include your IRBNet ID number with any correspondence with the IRB.

Sincerely,

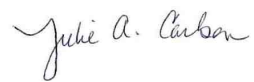
A handwritten signature in black ink, appearing to read "Mary Hadley".

Mary Hadley, Ph.D.
IRB Coordinator

A handwritten signature in black ink, appearing to read "Jennifer Veltsos".

Jennifer Veltsos, Ph.D.
IRB Co-Chair

Figure A1. IRB Approval Letter, Page 1



Julie Carlson, Ed.D.
IRB Co-Chair

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Minnesota State University, Mankato IRB's records.

Figure A2. IRB Approval Letter, Page 2