SoTL Grant Application Form
(2019-2020)

1 Basic Information

Title of project: Exploring interactions in epistemic framing during problem solving

Principal Investigator

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Requested Funds: $2470.00

2 Project Abstract

In recent years, there has been a move within the Physics Education Research (PER) community to move away from deficit-based models of student understanding and toward more asset-based models of student understanding. One of these asset-based models is epistemic framing, which refers to how a task is perceived, particularly with regard to what knowledge and tools are necessary for completing the task. Previous research has shown that students' epistemic framing has a significant impact on student learning during problem solving. In upper-level physics, productive problem solving often involves shifting between frames, particularly with regard to math in physics. Using this framework, we will analyze classroom video data from an upper-level Electricity and Magnetism course to explore how groups with individuals who are framing the task differently negotiate and make progress on a problem. This study is a part of a larger project whose long-term goal is to identify how instructors can help students shift into more productive frames during problem solving. In doing so, we hope to ultimately produce a theory based, research validated set of tools which teachers can use in the classroom.

3 Project Description

3.1 Purpose of Project

In recent years, there has been a move within the Physics Education Research (PER) community to move away from deficit-based models of student understanding, typically exemplified in literature on misconceptions and difficulties, and toward more asset-based models of student understanding, such as resources (Hammer, Elby, Scherr, & Redish, 2006; Sabo, Goodhew, & Robertson, 2016). One of these asset-based models is epistemological, or epistemic, framing. Epistemic framing refers to how a task is perceived, particularly with regard to what knowledge and tools are necessary for completing the task. Previous research has shown that students' epistemic framing has a significant impact on student learning during problem solving and in upper-level physics, productive problem solving often involves shifting between frames, particularly with regard to math in physics (Chari, Nguyen, Zollman, & Sayre, 2019; Modir, Thompson, & Sayre, 2017; Nguyen, Chari, & Sayre, 2016).

This study is a part of a larger project with collaborators at three other universities. The long-term goal is to explore how instructors can help students shift into more productive frames during problem solving. In doing so, we hope to produce a theory based, research validated set of tools which teachers can use in the classroom.

While we are in the early stages of this research, our long-term plan includes:

1. Reproducing work from the literature characterizing epistemic framing in the moment;
2. Using classroom video data to explore group dynamics when there is a framing 'mismatch" (i.e. when individuals in the group are framing the task differently);
3. Conducting instructional interviews to explore how specific moves shift student and/or group framing and what the instructor is attending to that prompts those moves; and
4. Using these data and analyses to identify a generalized set of instructional moves that both shift student frames productively and facilitate student learning.

The study proposed here focuses on the second strand, exploring interactions within groups where the individuals are framing the task differently and thus our research question is: *How do groups with a framing mismatch negotiate and make progress during problem-solving?*

3.2 Theoretical Framework

Our work is situated within the resources model of cognition (Hammer et al., 2006) and uses a model of epistemic framing that was designed specifically for problem solving in upper-level physics (Chari et al., 2019; Modir et al., 2017; Nguyen et al., 2016). This model consists of a two-axes: conceptual to algorithmic on one axis and math to physics on the other axis. While this framework assumes that both axes are continuous, it provides four distinct quadrants that we can treat as discrete epistemic frames and each is briefly described below.

- **Algorithmic Physics:** When in this frame, a student is using an equation or equations to solve a problem, or thinking in terms of which equation might be appropriate for the problem at hand.
- **Algorithmic Math:** This frame is typically more about the mechanics of using the mathematics (i.e. finding a derivative, solving an integral, etc). Typical "plug-and-chug" behavior would usually fall into this frame.
- **Conceptual Physics:** In this frame, one is thinking about the underlying physical system. This could be anything from trying to intuit what the motion of an object through space might look like physically to thinking about the inherent properties of a system.
- **Conceptual Math:** A student is in this frame if they are thinking about mathematical rules or properties. An example of this would be recognizing that the integral of an odd function over an even interval is zero, rather than actually solving the integral to obtain this result.

Given our research question, we are particularly interested in transitions between these frames.

3.3 Research Methodology

Early work on this project involved operationalizing each frame in order to reproduce work in the literature that characterizes framing in the moment. This operationalization involved developing a detailed coding scheme that includes how to identify when students are using a particular frame as well as what it typically looks like when they shift between frames. We are currently in the process of conducting inter-rater reliability tests for this coding scheme and training new researchers in being able to accurately apply the scheme.

For this project, we plan to utilize a methodological approach common in qualitative video-based research (Engle, Conant, & Greeno, 2007):

- Select a subset of episodes to analyze based on research questions and existing literature
- Generate narratives from this subset and identify initial claims
- Refine claims by enlisting other researchers and by searching for disconfirming episodes
- Identify possible explanatory factors through watching and re-watching data
- Use the identified factors to create a model
- Apply this model to the larger dataset and to other published work

For this project, we will start by looking for instances of framing mismatches, where students who are working together are approaching a problem using different frames. We will then use our coding scheme to map how they negotiate this framing mismatch in the process of solving the problem. Using these maps, we plan to look for patterns in the group interactions to better understand the role of framing in group problem solving.

3.4 Impact of Project

This study will further our understanding of epistemic framing, particularly with regard to its role in group problem solving. It will also contribute to our broader work to produce a theory based, research validated set of tools which teachers can use in the classroom to help their students become more productive problem-solvers. We will also be contributing to the broader shift from a more deficit-based model of student understanding to a more asset-based model.

3.5 Dissemination of Results

Since this is a long-term project, we see the dissemination happening in multiple stages over the course of the project.

- Our early results will be submitted to the proceedings of the International Conference on Learning Sciences in November 2019 and will focus on the work from Summer 2019.
- Results from the project proposed here will be submitted to the *Physics Education Research Conference Proceedings* in June 2020, with one or more undergraduate authors.
- In the later stages of the project, we plan to submit a paper to *Physical Review Physics Education Research* that will encapsulate the larger research project and also a paper for *The Physics Teacher* that will provide resources for instructors who want to implement these tools in the classroom.

4 Project Plan and Timeline

In the fall quarter, we plan to complete inter-rater reliability testing and researcher training for coding video data. We will then identify several relevant episodes from our data set where there appears to be a framing mismatch. Using our coding scheme, we will code a small subset of these episodes and identify initial claims. We also plan to begin conducting instructional interviews based on our preliminary work.

During the winter and spring quarters, we will code additional episodes in order to refine our claims and craft a paper for the *Physics Education Research Conference Proceedings*. We will also use these results to inform the analysis of the instructional interviews.

5 Budget

We are seeking funding for an undergraduate researcher to work with the project team to identify relevant episodes, code video data, analyze data,, and work on the manuscript for publication. Using the Undergraduate Research Assistant Program as a guide, the pay rate for students working as research assistants is $13 per hour for 75 hours per quarter. We are requesting funding for 2 quarters worth of work plus an additional 40 hours of work over winter break, for a total of 190 hours or $2470.

An initial offer will be extended to Kyle Benjamin, who did some preliminary work on this project during Summer 2019 and therefore already has IRB approval and some familiarity with the coding scheme. If Kyle is unavailable, an offer will be extended to Alana Uriarte, who is currently working on this project supported by the Undergraduate Research Assistant Program for Summer and Fall 2019 (in which case, the funding would be used for Winter and Spring 2020).

Selected References

Chari, D. N., Nguyen, H. D., Zollman, D. A., & Sayre, E. C. (2019). Student and instructor framing in upper-division physics. *American Journal of Physics*. arXiv: 1704.05103

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