

Building A Framework for the Process of Crafting and Using Definitions

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Abstract: I have built and will present an analytic framework for the process of crafting definitions for the purpose of classifying examples. I draw on data from undergraduate physical science students working to craft a definition of *threshold* for the purpose of helping younger people identify *thresholds* in the world. I present results around how definitional refinement begins and proceeds.

Major Issues Addressed and Potential Significance

The process of crafting definitions is an important yet understudied part of professional practice. Research in STEM education that focuses on this process generally falls into two camps: existence proofs that students can productively engage in crafting particular definitions (Atkins and Salter, 2010; Swinyard 2011) and more general framework building (Nachlieli and Sfard, 2003; Zandieh and Rasmussen 2010). These two more general frameworks focus on opposite ends of the spectrum of the length of a defining activity. Nachlieli and Sfard's work on "the activity of defining" (AoD) is focused on shorter clarifying moves. Zandieh and Rasmussen examine multi-week curriculum and focus on "the role that defining can play in students' transition from less formal to more formal ways of reasoning" and build a Defining as a Mathematical Activity (DMA) framework.

The general framework that I will present is unique in two ways. First, with respect to length of the defining activity, my framework falls between AoD and DMA: I examine a two-hour long process in depth. This focus allows for additional insight into when and how definitional refinement occurs. Second, my framework building relies on data from physical-science college students working on crafting a definition for a science-related term while previous work on general frameworks has focused mainly on mathematics education. This paper will focus on the research question, "how does definitional refinement begin and proceed?" An analytic framework will be presented that will support researchers studying the process of crafting definitions.

Methodological Approach

Data Collected: Workshops

In developing a framework for the process of crafting definitions, I wanted to first see how college students might engage in the process on their own with minimal facilitator interaction. I designed, implemented, and video-taped workshops where participants (groups of three upper-division undergraduate physical science majors) attempted to meet the design goal of crafting a definition of *threshold* to support younger people in identifying *thresholds* in the world. After explaining this design task, I let them work uninterrupted for two hours, returning only twice to briefly ask them to tell me what they had been working on or to ask them about some examples that had led to debate in previous pilot workshops. After collecting and analyzing data from two workshops, I asked two additional participants to engage in the activity individually so that I could ask follow up questions and probe their thinking in more detail.

Analysis Methods

The analytic framework I developed for the process of definitional refinement involves interplay between four main elements: the current state of the crafted definition, criteria for what makes a good definition, examples, and definitionally unarticulated knowledge (DUK). DUK is related to judgments that definers make about example categorization. These are judgments that have not been incorporated into their definitions per se..

This framework was developed through examining episodes of definitional refinement in the data, i.e. moments when participants changed words or phrases in their definition. The approach to naming important framework elements was top-down meets bottom-up. The research literature on crafting definitions and representations, related design tasks, suggested that criteria would be important to the process (Bowker and Star, 2000; Zandieh and Rasmussen 2010; diSessa et al., 1991). I developed a methodology to identify criteria in video data. After an initial viewing and content logging of the data (Jordan and Henderson, 1995), and through a process of naming important elements through analytic induction, it became clear that examples, the crafted definition itself, and DUK were central to definitional refinement. I developed a methodology to identify DUK as well, resulting in three important sub-categories of DUK. These framework elements supported the identification of a two-stage process present across many episodes of definitional refinement. This will be explicated in the results section.

Results

Definitional Refinement Begins in One of Three Ways

Empirical analysis showed that definitional refinement began in one of three ways. Participants either noticed a lack of fit between (1) an example and their crafted definition, (2) their definition and a criterion for what their definition should achieve, or (3) an example and some definitionally unarticulated knowledge. In the case of (3), participants noted that an example did not seem to fit and would describe this lack of fit using words not found in their definition. They would then choose to incorporate these new words into the definition. For instance, one student noted that she found a particular example problematic because it did not seem to include a “build up.” This phrase was not found in her definition but was then added.

Framework for How Definitional Refinement Proceeds

Another result of the empirical analysis is that definitional refinement proceeded roughly in two stages. After participants noticed a lack of fit between framework elements, there was an initial sense-making stage of understanding how important this lack of fit might be and deciding that it was worthwhile to work on. Participants then decided to work to meet one or more particular criteria. In making changes to the definition they almost always brought in further criteria to guide their work. This is outlined in the diagram, below:

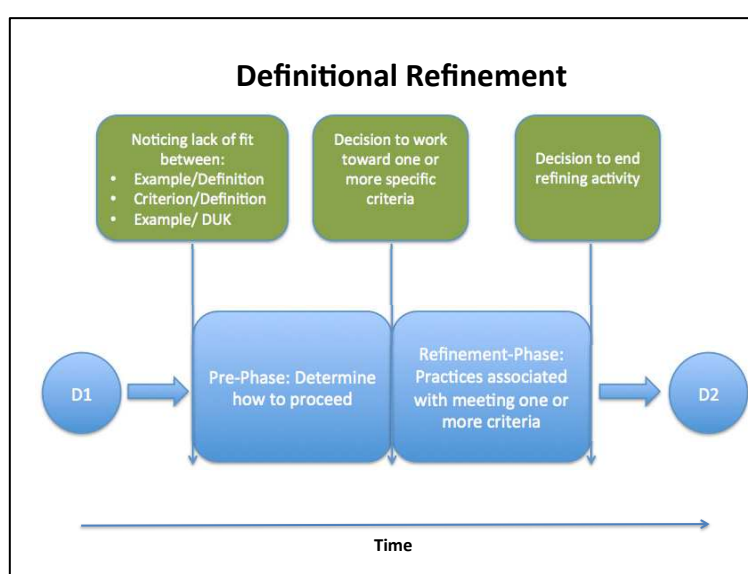


Figure 1. Definitional refinement proceeds in two phases from initial definition D1 to final definition D2. The blue boxes denote the two stages of definitional refinement. The green boxes denote transition moments.

Conclusion and Relevance to Conference Theme

With respect to the conference theme, this work examined college students engaged in a design task that is also a disciplinary practice: crafting definitions. The analytic framework provides support for researchers and educators in unpacking what is important to the process of crafting definitions. One limitation of this work is that the activity did not ask participants to compare their definition to other definitions. This would be an important additional source of definitional refinement to consider in future work.

References

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