

Applying a Framework for Characterizing Physics Teaching Assistants' Beliefs and Practices

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Abstract. Teaching Assistants (TAs) play an important role in supporting research-based instructional environments, yet the connection between TAs' pedagogical beliefs and instructional practices is not well understood. We build upon a broad foundation of research on the nature of pedagogical content knowledge to develop an analytic framework for characterizing how physics TAs both describe and enact their roles as teachers. In a previous work [1], we started developing a framework for TA pedagogical beliefs and highlighted examples of emergent differences between TAs along one particular dimension, *agency*. In this paper, we extend this framework to include TAs' *instructional goals*, and their methods and purpose of *assessment*. Using examples drawn from several semesters of interviews and classroom videotape, we apply this framework and describe instances of both strong and weak coordination between TA beliefs and practices.

Keywords: teaching assistants, teacher preparation, professional development

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INTRODUCTION

Graduate Teaching Assistants (TAs) are not only critical to the implementation of today's transformed classroom environments, they also represent the next generation of faculty who will be expected to adopt and implement similar reforms in the future. Being students themselves, graduate TAs are in a unique position of reconciling their roles as both teacher and learner. For many TAs, graduate school is a time to practice conducting and disseminating research, with only a minor emphasis on the development of instructional practices. The potential for long-term impact on future faculty encourages us to examine the nature and development of TAs' pedagogical beliefs at a critical time in their careers.

In physics, efforts to characterize faculty beliefs have led to a greater understanding of how curricula are adopted and implemented [2]. Previous research in this vein has tended to focus on either interview or observational data alone, one as a proxy for the other, thereby conflating the domains of professed and enacted beliefs. In the words of Kane et al. [3], this conflation amounts to "telling half the story," and limits our ability to investigate the exact nature and contextual dependence of instructors' pedagogical beliefs.

Recently, studies of math and physics TAs have employed a combination of video observations and

interviews to provide a more complete picture of TA beliefs [4][5]. However, there does not yet exist a framework for characterizing physics TAs' beliefs which spans the domains of enacted and stated beliefs. Our goal in this research is therefore to construct a robust analytic framework that captures both how TAs *talk about* and how they *carry out* their roles as teachers. We then seek to connect these two contexts for examining instructor beliefs.

ENVIRONMENT

The TAs under consideration served in consecutive semesters of calculus-based introductory physics courses (Physics 1 & 2) at the University of Colorado Boulder (CU), which have an average enrollment of 450-600 students per semester. TAs for these courses lead weekly recitation sections of 28 students using the *Tutorials in Introductory Physics* [6][7]. At CU, in order to address the need for greater instructional resources, we employ at least one undergraduate Learning Assistant (LA) [8] to work alongside the TA in each 50-minute recitation section.

The TAs and LAs all attend a weekly preparation session a few days before they teach. Following the model of the University of Washington [9], weekly Tutorial preparation sessions at CU are intended to guide graduate TAs and undergraduate LAs to think about and discuss potential student difficulties as they

complete the Tutorial in small groups. During this session, the TAs complete the same Tutorial pretest that their students do, view sample responses to the pretest, and work on the Tutorial in small groups while a course instructor models appropriate TA behavior.

Tutorial preparation sessions tend to be largely content-focused, with only occasional discussion of instructional approaches. It is expected that TAs will develop desirable beliefs and behaviors by having them modeled by course instructors or by LAs (who participate in an additional weekly seminar on teaching and learning [8]).

DESIGN OF STUDY

During the fall semester of Physics 2 and the spring semester of Physics 1, we collected video observations of the TAs and LAs for each course. Seven weeks of observations were collected during the fall semester, and twelve weeks during the spring semester. Results from this paper are drawn from Week 7 of the spring semester, “Work and changes in kinetic energy.”

In addition, we conducted pre- and post-semester interviews (~40 minutes in length) with each TA, which consisted of a TA video commentary followed by more general questions about the TA’s instructional role and their conceptions of teaching. A total of 8 TAs participated in this study.

FRAMEWORK

In previous work [1], we outlined a framework for TA beliefs and chose one dimension (“Agency”) to

highlight variation in TA beliefs and practices. In this paper, we extend this framework by fully describing agency as well as two more dimensions for instructor beliefs (Table 1). These dimensions are the result of iterative open coding along with consultation of existing literature [10][11]. We argue that these critical (although not exhaustive) categories underpin the practical, strategic choices TAs make when interacting with students or describing their own teaching.

Agency refers to who is the active participant (“agent”) in the learning process. We recognize that in the environment under consideration, both TAs and students are constrained in their possible modes of participation, and thus definitions of agency are subject to local context. For example, in this context we identify asking questions, contributing ideas, and initiating conversations as indicators of agency.

Goal of instruction corresponds to the intended outcome of the learning process. It includes a condensed taxonomy of the cognitive domain drawn from Anderson [12] as well as an epistemological stance toward answer- or sense-making. Although the curriculum under consideration is conceptually focused, other forms of knowledge are emphasized in various other course components.

Methods & Purpose of Assessment refers to how an instructor gathers information, and to what end this information is to be used. For example, an instructor may focus on a student’s written responses as an indicator of understanding, or their manner of participation in a group. This dimension also encompasses broader perspectives on the role and nature of assessment in instruction.

TABLE 1. Coding framework with definitions.

Definition of Belief Subdimensions			
Agency <i>Who is active in the learning process?</i>		Teacher	Emphasizing teacher direction; teacher tells and students follow or listen. Teacher decides when to stop/start discussion.
		Mixed	Involving some level of mutual action by both teacher & students.
		Student	Emphasizing student collaboration and/or self-direction. Teacher hangs back or imposes limits on own action.
Goal of instruction <i>What is the intended outcome?</i>	Knowledge	Factual	Basic knowledge involving memorization or recall (things you just need to “know”)
		Conceptual	Connected, organized knowledge involving theories, models, or generalizations
		Procedural	Knowledge to carry out a task or procedure
		Metacognitive	Strategic, reflective knowledge of own thinking
	Epistemological Stance	Answer-making	Focus on getting to formal, correct answer
		Sense-making	Focus on reasoning and making sense of the answer, rather than the answer itself
Assessment <i>How & to what end do I gather information?</i>	Form	Situated	Assessment within practice, e.g. observing behavior within social setting
		Isolated	Assessment removed from practice, e.g. giving a test
	Purpose	Formative	Assessment to inform practice or to guide learning
		Summative	Assessment to evaluate following instruction

TABLE 2. Summary of video coding results for TAs Green, Orange, and Blue. Numbers indicate the number of codes identified within the data set. Area of circle is proportional to number of codes; due to differences in coding densities, scale is not necessarily maintained between dimensions (separated by double bars) or between stated/enacted domains. For ease of comparison, a different shading is used for each TA.

		Agency			Goal of instruction						Assessment			
					Knowledge				Epistem. Stance		Form		Purpose	
		Teacher	Mixed	Student	Factual	Conceptual	Procedural	Metacognitive	Answer-making	Sense-making	Situated	Isolated	Formative	Summative
STATED	Green	○ ₁	⊙ ₁₁	⊙ ₁₆		⊙ ₅	⊙ ₅			○ ₂	○ ₁	⊙ ₅	○ ₁	
	Orange	⊙ ₁₈	○ ₃	⊙ ₇			○ ₂		⊙ ₅		○ ₂	○ ₃	○ ₁	
	Blue	⊙ ₁₀	○ ₃	⊙ ₅	⊙ ₅	○ ₃	⊙ ₈	○ ₁	○ ₂	○ ₁	○ ₁	○ ₂	○ ₂	
ENACTED	Green	⊙ ₁₈₅	○ ₃₄	○ ₁₃	⊙ ₂₅	⊙ ₈	○ ₁		○ ₃	⊙ ₉	○ ₁	○ ₃	○ ₂	
	Orange	⊙ ₅₁	○ ₂	○ ₁₂	⊙ ₂₀				○ ₃	○ ₁	○ ₄		○ ₁	
	Blue	⊙ ₉₆	○ ₁	○ ₂₁	⊙ ₁₀	○ ₂	○ ₂		○ ₄		○ ₁	○ ₁	○ ₁	

ANALYSIS OF BELIEFS

Table 2 summarizes the post-semester interview and video coding results for three TAs, codenamed “Green,” “Orange,” and “Blue”. All three are first-year TAs in Physics 1 who had previously taught a single semester with Tutorials (Green in Physics 1; Orange and Blue in Physics 2). We describe results for stated and enacted beliefs in turn, and follow with discussion.

In order to assess inter-rater reliability, two researchers independently coded two 20-minute TA interview excerpts. The researchers initially agreed on 83% of coded statements, which rose to 95% following a thorough discussion of the rubric and subsequent mediation of codes. Assessment of inter-rater reliability of the video coding rubric is in progress.

Stated Beliefs

We first note that no TA states a belief entirely in terms of student or teacher agency, although some TAs tend toward either side. Both Green and Orange describe at length the importance of allowing students to work together, but only Orange expresses a belief that the TA should step in and provide a correct solution after students have struggled.

Under the *Goal* dimension, we observe that Blue has the most codes pertaining to the Knowledge subdimension, indicating a clear focus on the physics content he wants students to learn. Procedural knowledge was the only knowledge subdimension mentioned by all three TAs. As for epistemological stance, Green and Orange profess sense- and answer-making beliefs respectively, whereas Blue is more mixed.

Finally, the TAs are less explicit in describing their beliefs about assessment in the classroom. Without ongoing pedagogical training, these TAs appear less accustomed to terms (and concepts) such as “formative” or “summative” in describing their own assessment practices. We note that Green tends the most toward emphasizing formative types of assessment, although both the amount and variation are not as great as in other dimensions.

Enacted Beliefs

The previous section focused on how TAs describe their own teaching. In order to extend the same analysis to enacted beliefs, we developed a coding schema to characterize patterns of TA behavior and discourse along these same dimensions. (In other words, we are moving from *perceived* practice to *actual* practice.)

We first observe that the TAs tend to emphasize teacher agency in the classroom—in particular Green, who spends the longest time on average per interaction. Although she asks questions frequently and allows ample response time for students, Green also dedicates a large portion of time to explaining or clarifying ideas to students. In one instance, a group interrupts her in the middle of an explanation to say, “We think we get it.” (Interestingly, Green mentions during her interview that TAs should know “when to stop.”) Compared to Green, Orange and Blue’s enacted beliefs regarding agency appear more consistent with their professed beliefs, both of which emphasize teacher agency.

Compared to the interview setting, all of the TAs shifted more toward emphasizing factual knowledge in the classroom. We also observe indications of coordination between stated and enacted in TAs’ epistemological stances. Orange was coded as only answer-making in the interview setting, and he had a higher fraction of this code in practice; the same was true for Green along sense-making.

Our earlier observation regarding TAs’ lack of focus on assessment in their stated beliefs appears to carry over to enacted beliefs as well. This is surprising to us, given the critical role of assessment in instruction. As additional weeks of video are coded, we will see whether this trend persists and if our coding schema is capturing TAs’ enacted conceptions of assessment—rather than our own.

DISCUSSION & IMPLICATIONS

We have presented a framework for characterizing TA beliefs, both in how they are stated and how they are enacted. We see that in some instances, TAs beliefs are coordinated between these domains, but not always. Furthermore, we observe differences between how TAs within the same course describe and carry out their roles as instructors. Subsequent work will characterize similar differences between these and other TAs, to provide a more complete picture of how TAs think about and enact their role in the classroom.

A particular affordance of linking these two domains is the opportunity to consider imagined or perceived practice against practice in reality. This exercise is not only valuable for us as researchers, but also for the teachers themselves. We consider self-reflection on practice to be the basis of any professional development model, and this framework could facilitate targeted self-reflection for TAs.

We should stress that we do not view apparent instances of “dis-coordination” as indicators of problematic or unsophisticated teaching. Rather, they illustrate the sorts of tensions that exist for teachers in

these environments. We view sophisticated teacher knowledge as inherently fluid and adaptive, and we therefore do not associate sophistication with any single subdimension or set of codes.

Finally, we acknowledge that these TAs are operating within a particular curricular environment, with corresponding affordances and constraints on instructor behavior. However, we argue that there is sufficient freedom for TAs to establish particular classroom norms through how they choose to engage with students [13]. We hypothesize that the different opportunities for student participation afforded by these norms will manifest in students’ attitudes and beliefs, which may represent avenues for future research.

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