Chapter 7 Chapter 7: Summary and future directions

7.1 Summary of findings

The preceding work has shown the usefulness of examining and understanding tutorial TAs' practices in the classroom and TAs' beliefs about teaching and learning. The different analyses show what TAs think about the curriculum they are teaching, what they perceive their role as a TA to be, and how their students support or challenge the TAs' interpretations. Further, the analyses show how all of these factors influence what TAs do in the classroom.

In Chapter Four, I presented a case study of Oscar, who does not buy into some aspects of the tutorials he was teaching. His lack of buy-in affects his teaching. Oscar does not value the idea of using everyday experiences as a basis for building physics knowledge, and this is reflected in the teaching episode when he instructs students to disregard the term "common sense." He thinks that the tutorials give too little guidance to students, so he provides this guidance through questions that carefully direct students to the information he wants them to have. Oscar's lack of buy-in is unfortunately representative of what I observed in UM TAs. This contrasts with the University of Colorado (CU-B) TAs, whose beliefs more closely align with the values of the tutorial developers. The differences in the social and environmental contexts between UM and CU-B suggest that the context can affect how TAs think about the tutorials they teach. Thus, TAs' beliefs influence how they teach, but the context in which they work can influence which beliefs are (unconsciously) chosen.

The next chapter presented different examples of TAs who "focused on indicators" while teaching, using relatively thin evidence such as correct answers or key words that the students understood. Again, TAs' beliefs supported this behavior. However, each TA had different beliefs that led to their focus on indicators. In fact, the two episodes involving Alan showed how different beliefs can be activated in different contexts to support the same kinds of behaviors. Alan's beliefs about his role as an instructor, that he should give students the benefit of the doubt on conceptual problems and that he should help students grapple with traditional problems, are not contradictory, but the context of each situation foregrounds different beliefs. The finding that various beliefs can support similar behavior in the classroom leads to the recommendation that professional development (PD) should address the beliefs that underlie TAs' classroom practice. PD that only targets the behavior will not be as effective, because TAs will continue to rely on the beliefs that supported the less desired behavior.

The final data analysis chapter advocated a new perspective on TA PD, illustrated with a case study of Alan. Part of treating Alan with respect was looking for and understanding the beliefs that he had about teaching and learning. That allowed me to see his teaching practices as reasonable and motivated by a desire to help his students. While I did not always agree with his teaching decisions, considering his beliefs also provided me with the opportunity to look for productive seeds in his beliefs and experiences that could be the basis for more effective PD.

7.2 Limitations of these findings

One of the limitations of this work arises from the simple fact that this work was done with particular TAs, at two particular universities, at a particular time. It is difficult to know the effect of all the contextual factors. If, instead of examining TAs at the University of Maryland and the University of Colorado, I had examined TAs at a different university, the demographic characteristics of the TAs and their beliefs and knowledge, might have been different. For example, TAs who were less fluent in English might find communication with their students to be a primary concern; this was rarely an issue for the TAs I studied. Similarly, the characteristics of the students and the universities would be different. If I had studied TAs who taught students majoring in the physical sciences, those students might see physics as more immediately applicable to their chosen field. These students might value physics differently than students in the health and life sciences, which would in turn influence their interactions with their TAs.

Another limitation that all the TAs was voluntary participants in the study. A majority of the solicited TAs at both the University of Maryland and the University of Colorado agreed to be interviewed, but we cannot know why they participated, or why others declined. It may be that those who agreed to participate were particularly interested in improving their teaching, or were more likely to be outspoken about their concerns and problems with the system in which they were working.

7.3 The value of this dissertation to Physics Education Research

This dissertation aims to add to the field of Physics Education Research by drawing attention to a situation in physics education, TA instruction of undergraduates, which has the potential to have great impact and which has been minimally researched. PER can benefit from paying more attention to TA instruction in at least three ways. First, when TAs' instruction is improved, it can improve undergraduate learning as well as undergraduates' attitudes about physics. Next, TAs who are teaching using research-based curricula are forming their opinions about reformed instruction and the value of PER; an unsuccessful experience may impact their future willingness to consider using reform materials or color their interactions with the PER community. Lastly, a significant portion of future physics faculty will hold a TA position at some point; this TA position may be most (or all) of the teaching experience they have before running their own class.

I also extend to TA research the theoretical position, stemming from the resource framework, that sees value in understanding and building on students' naïve ideas. By applying this idea to the professional development of TAs, I hope to encourage the PER community to treat TAs as partners in the undertaking of educating students and not as either holders of pedagogical misconceptions nor as blank slates, as sometimes seems the case.

7.4 Directions for future research

One way this work could be extended is to explore how different TA practices affect their students' learning. In Chapter Five, I discussed TAs' focus on indicators, when TAs use relatively thin evidence to determine student understanding. We expect that this practice prevents TAs from noticing when students might need additional assistance. However, we do not know how this actually affects students. If students have a tutorial TA who focuses on indicators much more than another TA, do those students gain less conceptual understanding than the students of the second TA? Or do the common contextual elements that all the students share, such as the tutorial and the professor, mean that the effect of the TA is relatively muted?

Another area that might be explored is how graduate students are affected by their TA experience. One might speculate that teaching an introductory course could improve graduate students' physics knowledge, as many instructors feel that they only really understand a subject once they have taught it. Does teaching affect graduate students' epistemological beliefs? What pedagogical skills do TAs learn while teaching? Do TAs feel an increased confidence in their ability to teach and are they more interested in teaching after their TA experience? If future research could show specific skills that TAs gain through teaching, it could be used to support the call for increased attention to TA PD. This evidence could be convincing to physics departments, who want to provide their graduate students with the skills they will need as future faculty members, and to graduate students, who have many demands on their time, but who often expect to seek careers as professors.

Lastly, it is worth exploring how PD can be made most effective. Because the time available for TA professional development is so limited, there is pressure to use that time as efficiently as possible. Perhaps PD should focus on eliciting TA beliefs, through targeted readings and discussion groups. It might be effective to focus on TA's pedagogical content knowledge, which includes knowledge about common difficulties students have or different ways topics can be presented. It might also be the case that instruction in a typical PD course, where TA meet weekly as a group to learn about general topics, is not as useful as personalized feedback from a TA instructor who observes each TA's classroom. Alternatively, it might be the case that a graduate student TAs can serve as valuable resources to one another and form the beginnings of a professional community.

Once again, I note that the kind of in-depth analysis presented here provides important benefits for research-based professional development. However, I do not think it will be necessary to do these kind of in-depth analyses for *every* TA to whom we offer professional development. Research with students has shown that there are common issues, and the same is likely true for TAs. However, we cannot guess what these issues might be, but rather we should observe TAs' practice to build up a useful corpus of TA ideas and practices.

7.5 Implications for TA professional development

The research presented here suggests several ways PD could be improved. We can begin by paying more attention to TAs' beliefs. As discussed in Chapter Six, we need to understand TAs' beliefs before we can create PD that is responsive to these beliefs. These beliefs could be elicited in a variety of ways: open-ended surveys, journal assignments in which TAs reflect about their teaching, and video clubs where TAs watch videos of each other's teaching and discuss them. Once a TA instructor has a better understanding of how the individual TAs she is training think about teaching and learning, she can select or create activities to address particular issues and build on the productive seeds she identifies.

Another way to make PD more responsive is to offer more types of PD. Price and Finkelstein (2006) offered a tiered program, in which graduate students participate at varying levels of commitment. In their program, a TA may begin by preparing a small practice lecture (a "micro-teach") that they give to a group of fellow TAs in order to receive feedback. Other activities include developing curriculum or guest lecturing, or becoming the instructor of record of a course. These activities require different time commitments and offer greater or lesser opportunities to improve teaching skills. By offering these choices, departments would be more likely to involve TAs who are genuinely interested in the PD activity they have chosen. Such a tiered program would also improve the chances that TAs get preparation that they need; if a TA expects that he will work as a professor in the future, he may be more likely to seek PD that prepares him for that job, in comparison to a TA who expects to work in a non-teaching industry job.

This research also points to a need for departments to create a supportive teaching environment for their TAs. As Chapter Five showed, TAs absorb the larger metamessages about teaching that their departments and institutions convey. If the department and the university create programs and policies that encourage attention to improving teaching, and if these programs and policies accurately reflect the values of the department, TAs may be more likely to spend the time and effort needed to reflect upon and improve their teaching. A TA instructor alone cannot institute these kinds of changes, because a single person cannot define the norms of the community. The kinds of changes that affect TAs' context, such as giving TAs credit for PD courses they take or compensating faculty for the time they spend supervising TAs, would more likely occur when there are multiple people in the physics department committed to improving TA instruction.

7.6 Reflection: obstacles and support for improved TA PD

Improving the professional development offered to physics TAs is not an easy task. Increasing the supervision and feedback that TAs receive might mean compensating faculty who agree to mentor or train TAs, or it might mean that someone is hired specifically for this task. Offering academic credit for TAs who participate in PD courses means that departments or the grants that pay graduate student salaries are billed for extra course hours. If, as sometimes seems to be the case, the current social and environmental context does not offer much to support TAs' teaching, then the changes required could be far-reaching. Such changes have the potential to shift resources and attention away from the research that is the primary mission of many departments. It also takes time, attention, and skills to create a professional development environment where TAs feel comfortable examining their teaching practices. All of these changes require either money or time to be used differently, and those are both scarce resources in departments.

There are just as many reasons to be hopeful that TA PD can be improved. There is a large body of teacher literature that can help inform TA instructors; using it we can better anticipate the some of the difficulties new instructors face, the environmental factors that can impede or support effective teaching, and the beliefs and knowledge we might expect novice instructors to have. Next, an increasing base of research-based PD for science TAs is being published, which will minimize the need for each TA instructor to “reinvent the wheel”. Departments and institutions are motivated to provide support for improved TA PD because it allows them to make progress simultaneously toward two goals: increased undergraduate learning and graduating doctoral students who are better prepared for their future careers. Lastly, I am encouraged by my experiences with TAs, who, in spite of many demands on their time, regularly approach their teaching duties with a sincere desire to help their students learn.

Appendix 1 Characterization of TA Buy-in

In order to better understand the individual TAs' buy-in, their transcribed interviews were coded. The interview questions were open-ended in order to respond to TAs' replies. A typical question was, "What do you see as the advantages and disadvantages of tutorial-style teaching, for you, and for the students?"

To develop categories, we examined a subset of TA interviews, selected quotes in which they were discussing aspects of tutorials, and then created categories from them. Thus, the categories are a reflection of the characteristics of tutorials that TAs considered noteworthy, rather than the aspects of tutorials that the developers value. After these categories were established, we coded all the transcripts from TA interviews.

If a TA discussed some aspect of tutorial, that talking turn was categorized. Individual turns were put into multiple categories when appropriate. All interviews turns were sorted into one of the categories or coded as not relating to tutorials (an example of the latter would be a discussion of how the TA learns best). Each comment labeled as predominantly showing buy-in (aligning with the developers' ideas), predominantly not showing buy-in (not aligning with the developers' ideas), or as mixed. All of the comment ratings in a category were considered together to determine a rating for each TA in each category. (Again, they were rated as predominantly showing buy-in, anti-buy-in, or as a mix.) If a TA did not mention that aspect, there is no code for that TA in that category.

One researcher did all of the coding. To check inter-rater reliability, a second researcher was given an hour of training and then was given 21 quotes to which the first researcher had assigned at least one category. For each quote, the second coder assigned categories to the quotes and coded whether the TA was bought in, not bought in, or "mixed" with respect to each category.

For the buy-in codes, there was 86% agreement, with no disagreements between "buy in" and "anti-buy-in." Instead, all the disagreements were between "mixed" and one of the other two categories.

The coders agreed on the categories assigned 79% of the time, but about half of the mismatches were due to a disagreement about whether a second category needed to be assigned (e.g., the first coder assigned two categories while the second coder assigned just one). In those cases, the coder who assigned just one category was asked to assign a secondary category. The secondary category chosen agreed, in two of the three cases, with the secondary category assigned by the other coder. In summary, the two coders disagreed on categories 21% of the time: 12% were disagreements about category choices and 9% were disagreements only about whether the "signal" from a secondary category was strong enough to warrant a category assignment.

Table 2 shows the designation each TA received in all of the categories on which he commented. The designations are indicated with colors: light blue for buy-in, medium blue for mixed (both aligned and nonaligned comments), and dark blue for anti-buy-in. A TA's comments are considered mixed if less than approximately three quarters of the comments in that category were aligned (or not aligned). If a category had no comments from a TA, the corresponding box is gray.

As an example, consider Chris, the UM TA shown in the fifth column, labeled "C." When he discussed group work, he said that he valued it for students because it gave more of them a chance to ask questions, allowed them to teach each other, and provided them with the chance to focus on their own particular difficulties. He also appreciated it as a teacher because he didn't have to devise a "50-minute show" and because it better prepared him to answer the questions he'd expect when he was a lecturer. His only concern was that having to answer student questions on the spot took more time than delivering a prepared lecture. Because his comments were predominantly aligned, his rating for this category was "Buy-in."

Chris was concerned that the qualitative focus of the tutorials did not prepare students sufficiently for the MCAT and their quantitative, multi-step homework problems. He did not suggest any positive aspects of the emphasis on qualitative physics reasoning. As a result, he was rated as "Anti-buy-in" for this category.

Chris's assessment of the structured nature of tutorials was mixed. Because the tutorials were a prepared curriculum, Chris liked the limited preparation required, but found it difficult to use material that was unfamiliar. He said that at the beginning, it "was kind of hard to be using someone else's words effectively, and I kind of got a handle on that and also got a handle on how to put my thoughts in it…." His buy-in that category was accordingly rated as "Mixed."

The UM TAs were interviewed twice, at the start and end of the semester they taught. The comments from these two interviews were combined before they were rated. The CU TAs were interviewed once, near the end of the semester they taught. We might expect that a grouping of initial and final assessments would obscure changes that occurred in UM TAs during the semester they taught. In order to estimate how much change might have occurred, we counted the number of times that we could have observed a change (i.e. the number of times a TA commented on a particular category in both the initial and final interviews), which was 57 instances. We then tallied the number of times our codes of a TA's values changed, for example from mixed to positive, which happened 17 times. This means that changes in TAs' values occurred about 30% of the time, where about two-thirds of the observed changes were positive (i.e. from mixed to positive or negative to mixed). This is not an extensive amount of change, and it is consistent with our informal observations.

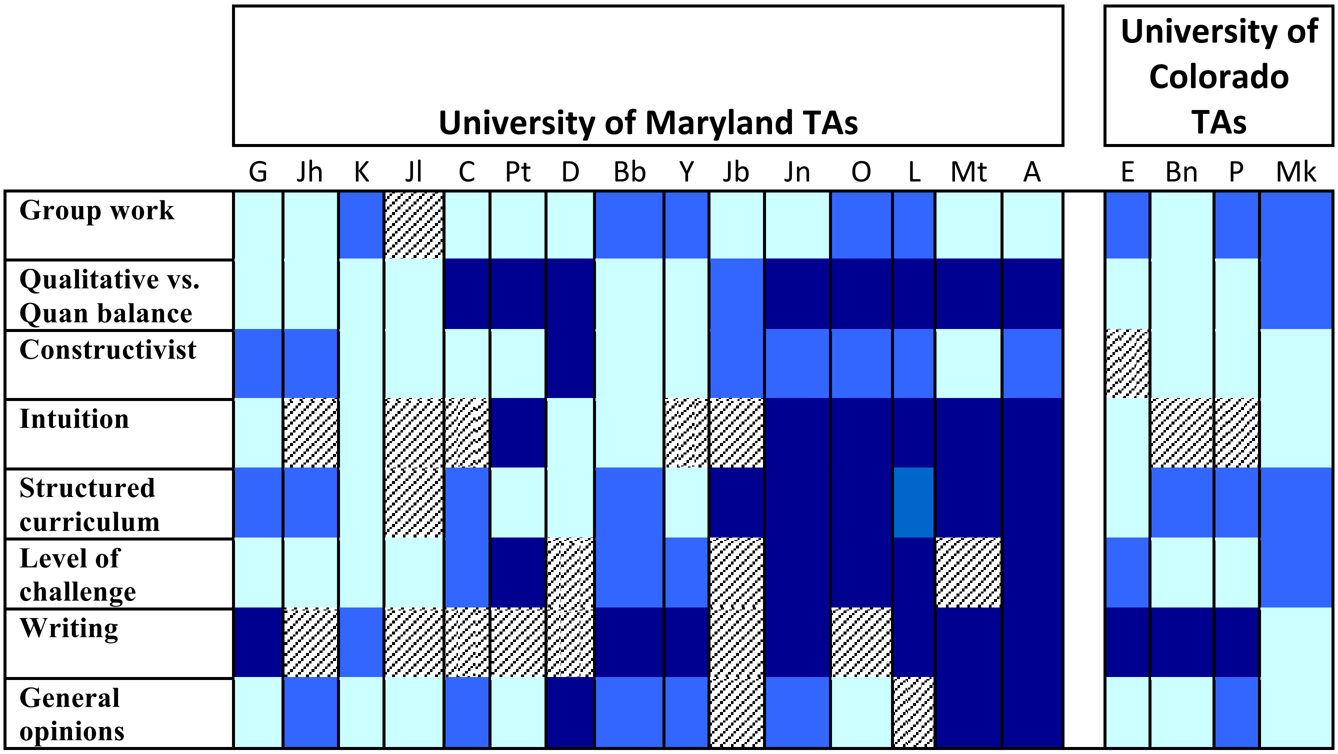
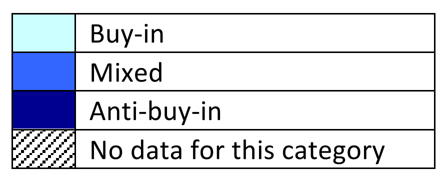


Table 2. The alignment of each TA in each category on which he commented.



Appendix 2 Interview questions

The following questions were asked during the open-ended interviews we conducted with the TAs.

1. Have you taught before?
2. How is the course going?
3. How is discussion section going?
4. What do you see as the advantages and disadvantages of tutorial-style teaching: for you? for the students?
5. How would you recommend tweaking the current format?
6. Do you think your students are learning better, worse, or the same as they would in a regular- style recitation section?
7. What's hard about teaching this way, and what's easy?
8. Do you think that the course (lecture and tutorials) help teach what students should be learning in a physics course?
9. (Asked only in the 2007 and 2008 interviews) When teaching tutorials, what did you see your job as?

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