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Operationalizing the orthogonal role of a Learning Assistant in the classroom to analyze epistemological development

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Abstract

Learning Assistants (LAs) are students trained to facilitate discussion among student groups for socially mediated learning. They are distinct from teaching assistants and tutors in that they receive additional pedagogical training based on constructivist models of teaching and learning (e.g., sociocultural theory [1]). Their role in the classroom is to facilitate and guide, often through questioning, in ways that will help students reach understanding on their own. Studies on the Learning Assistant model have demonstrated numerous benefits, such as increased conceptual understanding; an increase in positive affective dimensions such as belonging; and an increase in well-trained and enthusiastic future STEM teachers. While existing education research has illustrated positive impacts on students in STEM classrooms, less work has focused on the personal and epistemological development of the LAs themselves.

In this paper we provide an analytical lens through which to assess epistemological development of LAs. This is critical to understanding and promoting LA development, but has been relatively overlooked to date. We define epistemology as the beliefs, ideas, and conceptions one has about the justification, nature, and source of knowledge. Within the Learning Assistant program, there are many avenues for participating LAs to reflect on and potentially rearrange their epistemology. To analyze LA epistemological development, we turn to Baxter Magolda's Epistemological Reflection Model, which describes student epistemological stances for the role of learners, peers, and instructors. In this paper, we adapt the model to account for the unique role of LAs in educational settings.

Through analysis of semi-structured interviews and written assignments with LAs before and after participation in the LA program, we find that the role of the LA as narrated by the participants is orthogonal to that of peers, learners, and instructors in the classroom. Further, the role of the LA evolves over time, often as a result of incidents in the classroom that prompt LAs to confront and reorganize their beliefs about teaching, learning, and knowledge. Here, we operationalize the Role of the LA within the context of the Epistemological Reflection Model to articulate the ways LAs are distinct from both instructors and peers and discuss how instructors employing LAs or other near-peers may productively engage with their LAs' epistemological development. This study constitutes an extension on previous work and serves as a jumping-off point for further study on the affordances of pedagogical training for near-peers.

1 Introduction

Learning Assistants (LAs) are undergraduate students trained to facilitate discussion among peers during group work activities. Learning Assistant programs follow a three-pronged model that address theory, content, and practice. Each prong is meant to prepare LAs in different, complementary ways for their unique role. First, novice LAs take a seminar course (Seminar for Learning Assistants) in which the instructor motivates the LA model by discussing the cognitive and affective benefits of active learning in STEM. For example, the seminar covers pedagogical topics such as metacognition, mental models, and the use of strategic questioning. It also addresses systemic issues that influence learning such as stereotype threat and institutionalized forms of sexism in STEM education. Second, LAs attend a weekly content preparation with the instructor of the course. In this content preparation, LAs engage in the same cognitive tasks as the students and anticipate potential questions from students and possible approaches to instruction. This helps LAs prepare themselves for the kinds of questions they might get from students and prepare different lines of questioning and facilitation. The final prong is the work in the classroom. LAs work in pairs in the classroom and engage with students individually as well as in groups. LAs have the authority to address student questions and concerns independently, and are also empowered by the instructor to use instructional tools as the need arises.

As active learning strategies and group sensemaking activities in specific become increasingly popular, the LA model has been deployed and studied at an increasing rate[2, 3, 4, 5, 6]. Research on LA programs demonstrate that students in LA-supported courses often exhibit higher learning gains on validated instruments than their non-supported cohorts [7], and LAs themselves will exhibit similar conceptual learning gains in courses with similar content [8]. In some programs, LAs report a deeper sense of discipline-based identity [9]. LAs who go on to become K-12 teachers tend to be more confident and have positive attitudes towards diversity, equity, and inclusion (DEI) efforts [10]. Recently, another avenue of research regarding LAs has emerged: the potential for LAs to prompt course redesign and institutional change. Using frameworks such as students-as-partners, researchers have detailed how instructors' views on the goals and purposes of coursework may change throughout the process of incorporating LAs into their curricula [2, 11]. In sum, instructors, students, and LAs all stand to greatly benefit from robust LA programs [12].

Our research on the role of LAs is part of an extensive project addressing high DFW rates at the authors's institution in introductory mechanics (PHYS 141), statics (ME 211) and dynamics (ME 212). Introductory mechanics courses form the foundational coursework for a wide range of engineering disciplines, and these courses are also typically taken at a point in which engineering students might be most at risk of withdrawing from their engineering major [13]. While the work on LAs has been predominantly done in the physics discipline, it is notable that for our population, the majority of LAs were engineering majors supporting physics courses. Thus, it would behoove the engineering education community to further explore how future engineers' epistemologies are affected by their undergraduate instructional support experiences.

Given this extensive background and interest in Learning Assistant programs, our goal was to further elucidate the ways in which the role of the LA is unique to STEM educational contexts. To address this goal, we employed an established model of epistemological development:

Baxter-Magolda's Epistemological Reflection Model (BM model)[14]. The BM Model characterizes college student epistemological development from absolute to contextual ways of knowing as students move from seeing knowledge as fixed, inert, and possessed by authorities to something that is situated, negotiable, subject to falsification, and subject to scrutiny from peers and knowledgeable others. Epistemological development is described as a transition from Absolute ways of knowing to Contextual ways of knowing. This development is characterized in terms of salient dimensions of higher education learning environments (e.g., the role of the instructor, the role of evaluation, the role of peers). This model provides a useful way to understand how students' thinking around teaching, learning, and the nature of knowledge changes. The BM Model is described in Table 1.

Given the focus in the LA program on preparing the LAs to facilitate discussion with constructivist underpinnings, it is natural to question the extent to which their epistemology– their ideas, conceptions and beliefs about the nature, source, and justification of knowledge– are influenced by their training and work in the program. Further, the BM model operationalizes the role of three main participants in the learning processes: learners, peers, and instructors. A first major step in continuing to develop effective LA programs that address epistemological development is to operationalize the role of the LA within this context. Thus, our research question is: In what ways do the LAs conceptualize their role as complementing, extending, or aligning with the roles of other dimensions in the BM model?

By design, LAs do not neatly fit in any role, nor, we argue, in a sort of linear combination of peer, instructor, and student roles. Instead, we find that the LAs internalize their role as outside the plane of the traditional classroom hierarchy, affording them unique perspectives into learning and teaching. These distinct experiences contribute to their epistemological views. Here, we propose the term "orthogonal" to describe that the role of the LAs, to denote that their role may be perceived as perpendicular to a plane composed of the student-instructor axis.

In this paper, we present findings from a qualitative analysis of interviews with LAs before and after participation in the LA program to elucidate the unique role of the LAs. We conclude with a discussion of implications for future work on epistemological development of near-peers in instructional support settings.

2 Methods

This research is part of a larger project developing educational and pedagogical approaches to mitigate equity gaps in mechanics courses (*i.e.*, physics, statics, dynamics) and enhance student belonging in STEM [15]. To address our present research question, we collected data from Learning Assistants (LAs) who were in their first or second quarter working in the program and thus enrolled in the LA seminar. We combined semi-structured interviews with bi-weekly reflective journal responses to examine the different ways that LAs engage with students and describe different challenges and personal and professional development. We used qualitative methods that began with *a priori* coding using the BM Model (Table 1 and, through iterative analysis, evolved to account for the unique role of LAs in classroom spaces. Given that LAs have become an important element of STEM education in recent years [16, 17], it seems important to revisit the model in ways that can expand it to account for changes in learning environments. The

	Absolute	Transitional
Role of learner	Learners verify knowledge acquisition with experts. Explanations are good if reminiscent of initial information. Learning is a receptacle of knowledge.	Learners work to “understand” ideas and concepts. Learner focuses on practical applications of material.
Role of peers	Peers “fill in the gaps” by providingmissed notes, assignments, or specific insights. Work with each other to create a relaxed atmosphere.	Peers serve as debate partners to reinforce learning. Peers offer different opinions and viewpoints.
Role of instructors	Instructors are expected to explain the materials in lecture and homework assignments. Instructors should tailor their explanations to students and may articulate fixed ideas of ”how one learns.”	Instructors should establish rapport with their students and be approachable. Instructors challenge students to think and apply ideas.
Evaluation	Grades are indicative of acquired knowledge. Tests are for students to “prove” they have acquired the correct knowledge as evaluated by the instructor.	Grades reflect an ability to apply knowledge. Accounts for individual differences in assessment and emphasize fairness and practicality.
Nature of knowledge	Knowledge can be comprised of differenttakes regarding a series of related facts. Personal interpretation resolves the difference between opinion and fact. The central question becomes whether ornot one has achieved the correct interpretation.	Focuses on uncertainty and lack of knowing because of personal judgment Resolves uncertainty by logic and research

Table 1: Codebook describing the various agents in learning process and their roles in absolute and transitional epistemologies.

following sections offer more detail on the data collection, analysis, and an updated codebook.

2.1 Sampling and Data Collection

We recruited students who were enrolled in the LA pedagogy seminar between fall 2019 and fall 2020 (4 academic quarters) for two key reasons. First, Ríos led the pedagogy seminar during this recruitment period, and so the sample represents a convenience sample. Nonetheless, to protect students, Lutz recruited participants, conducted interviews, and did not share data until after Ríos had submitted final grades for the quarter. Second, LAs enrolled in the pedagogy seminar were more likely to be second- or third-year students and, according to the BM model, also more likely to be earlier in their stages of epistemological development. Part of the goal of this research is to understand how participation in LA programs might influence or change LA epistemology over time, and so we recruited participants who might be more likely to demonstrate epistemological changes or growth over an academic quarter. On average, 20 LAs are hired for the introductory physics courses and four LAs for hired for statics and dynamics engineering courses each academic quarter. Some LAs support more than one course. Learning Assistants are hired departmentally, along with graders. Peers tutors for the relevant programs (physics and engineering) are housed in a separate academic office.

In total, we recruited 20 LAs for at least one interview and conducted a total of 33 pre/post interviews. In both cases, interviews were semi-structured to allow for both consistency across participants as well as the flexibility needed to explore unexpected themes or findings during data collection. The initial interviews occurred during the first three weeks of the quarter and were designed to serve as a baseline for understanding subsequent development. Topics were centered on the *Nature of Knowledge* and the *Role of the Instructor* and asked questions related to how LAs might assess or evaluate knowledge claims, and how they might make claims about the certainty of their knowledge. Follow-up interviews were conducted during final exam week (week 11 after a ten-week quarter) and questions focused on the *Role of the LA*, *Role of Learner* and *Role of Peers*. These interviews were also used to more deeply explore and corroborate particularly impactful events documented in the reflective journal responses. Reflective journal responses were adapted from Lutz and Wallin [18, 19], and asked participants to reflect on and unpack a significant challenge they experienced as LAs over the last two weeks. For a full discussion of the data collection protocols, see Ref [20]. Taken together, the data offer an in-depth look into the development of LAs over 10 weeks and the kinds of salient challenges that contribute to that development. Participants were given pseudonyms to protect their anonymity.

2.2 Data Analysis

For the present research, analysis primarily centers on interview data and is supported by reflective journal responses. Analysis was iterative and used a combination of inductive and deductive coding. We began with Baxter Magolda's Epistemological Reflection model noted in Table 1 and each segment was coded along two dimensions of the framework: *Domain* and *Way of Knowing*. For our purposes, the *Role of Learner* domain describes the students in LA-supported courses (*i.e.,* the students among whom the LAs help facilitate discussion), the *Role of Peers* domain describes the peer group involved in discussion-based work, and the *Role of*

the Instructor denotes the role of the instructor of record for the LA-supported course.

Coding allowed us to identify epistemological shifts along specific dimensions of the model and better understand how different challenges and experiences might affect particular kinds of epistemological changes. To observe these changes, we examined LA language related to their approaches in class, their beliefs about learning, the ways they might justify their understanding, and other relevant epistemological dimensions. For example, a shift in the *Role of Peers* from an Absolute to Transitional way of knowing might be exemplified in a shift in talking about others as additional "explainers" to a view that emphasizes the importance of multiple perspectives in developing understanding or establishing a position.

While we began with an *a priori* codebook based on our theoretical framework, we expanded it to include the *Role of the LA* as an additional domain of the codebook. To operationalize this code, we examined transcripts for instances in which participants made reference to their unique position in the educational setting. For example, participants would often describe how being an LA is unique because of the need to fill the role of both teacher and peer and how straddling that line affected their interactions with students. For example, the following quote offers an example of an LA coming to understand their unique, orthogonal role in the classroom and in facilitating learning.

> *So coming off of that, it was– the LA position, which was more of a– like, you're not a TA. But you're also not a teacher. But you're there to help. To me, it seemed like you were, like, a tutor for the class at least initially. And I think over the course of the quarter, it became less of like you're these students' tutor. –Harley*

Harley notes a wide range of roles that are available in the traditional educational settings (*e.g.*, TA, tutor, teacher). He expresses that none of these roles align neatly with what an LA is supposed to do in the classroom. He also notes how he initially approached his role as if he was a tutor and how that perception shifted over the quarter as his role became less compatible with what he perceived as tutoring.

Another LA echoed these sentiments, noting how his role differs from both peers and professors and how he therefore engages with students in ways that are different from either:

> *I think a lot of the special nature of an LA is because we're also students. And yeah we're teaching students in a classroom, but we're also their peers. That's a big part of it too, is that we're in the middle between the professor who has years, decades of experience and the students who have not seen this material before. –Finley*

Here, Finley discusses how his particular relationship to both the content and the students in class put LAs in a unique position within an educational context.

Quotes such as these prompted several rounds of the revision and refinement to the codebook to account for this unique role–or *Domain* in the model–and to examine language that mapped onto the different dimensions associated with *Ways of Knowing*. Notable in both of these passages are the different combination of traditional roles that LAs seem to reach for to describe their own position in the classroom, but how none of those quite encapsulates the totality of their experience, or what makes it productive for learning. In response to these kinds of passages and

descriptions, our analytic process entailed recoding the data to operationalize the different ways of knowing associated with the *Role of the LA*.

2.3 Operationalizing the Role of the LA

We combined concepts from Baxter Magolda's model with data from LA interviews and reflections to expand our codebook and operationalize the unique, orthogonal role occupied by LAs. In addition to the *a priori* codebook presented in Table 1, we added a new domain to describe the different dimensions of epistemological development in terms of the role occupied by learning assistants. We operationalized these codes in terms of both absolute and transitional knowing, as these were the primary epistemological positions from which LAs were operating. Here, these additional codes broadly group the ideas, beliefs, and conceptions that LAs espouse about how they perceive themselves and their roles in the classes they support. Table 2 provides operational definitions of the *Role of the LA* that echo the language and form of those in the original codebook, but that also highlight a new domain of epistemological development.

	Absolute	Transitional
Role of Learning Assistant	LAs provide high-quality explanations to students that offer a different perspective from instructors LAs offer tips and tricks for solving problems and advice for success in class	LAs emphasize communication and listen for student perspectives and misconceptions LAs recognize and attend to interpersonal and affective dimensions of learning

Table 2: Addition to existing codebook to operationalize the role of the learning assistant in the present learning context.

These definitions arose from collaborative coding of the interviews and examination of instance in which LAs made reference to the ways their role was unique or different from others in the classroom. However, given that epistemological development occurs over a relatively long period of time (*i.e.*, at least four years of college), our data illuminate epistemological shifts in early stages of the process. Thus, we only operationalize the *Absolute* and *Transitional* ways of knowing. We do not have enough data covering the Independent and Contextual ways of knowing to operationalize these within the present study. However, these findings are also consistent with Baxter Magolda's original work in which she demonstrated that most students in their second or third of college espouse beliefs mostly consistent with Absolute and Transitional ways of knowing. Here, we further operationalize the existing domains and ways of knowing from the perspective of a Learning Assistant and introduce a new domain in the *Role of the LA*.

3 Results and discussion

It is tempting to insert the LA into an intersection of learner, peer, and instructor, but this collapses the critical role the LA plays in *extending* the role of the learners, peers, and instructors for each of those actors in the classroom. Upon inspection of the theoretical foundation in Section

2, it is readily evident that the *Role of the LA* does not comfortably fit in any of the preconceived domains, or even in an intersection of domains. The primary finding of this paper is the operationalization of the *Role of the LA* as a natural extension of Baxter Magolda's framework. Hence, the only appropriate term we concluded aptly described this role is "orthogonal" to the role of peers, learners, and instructors. In the following section, we offer some examples of how LAs described their roles and the processes that helped us make sense of and operationalize this domain.

A common theme among participants was the difficulty that presents itself precisely when LAs experience the dissonance associated with the lack of a defined role consistent with being a student, peer, or instructor. Many LAs described this challenge as somehow simultaneously existing in two extremes: student and teacher. This conceptualization of their role existed in both Absolute and Transitional epistemologies, but to different effects.

In the following quote, the interviewer asks an LA to self-evaluate when they are "most effective as a Learning Assistant."

> *I feel most effective when I feel like I've given myself enough time to prepare for what kinds of questions students might be asking. And the example I have for that is that one of the professors I worked with would bring up common student misconceptions in a meeting with me before that week's material, saying that, "I know that a lot of students might have this wrong idea about what we're learning today," or, "They're going to be confused right here." And I think that I feel most effective when I'm at least prepared for some of the most common questions that students are going to have. –Charlie*

Here, Charlie describes a type of Absolute epistemology. In his view, he is most effective when he has "given myself enough time to prepare for what kinds of questions students might be asking." This suggests that Charlie thinks of himself as a dispenser of knowledge. Adequate preparation of the material would allow Charlie to be an "effective" LA by having the correct answers to various potential questions ready. The role here is orthogonal because Charlie recognizes that he will be interacting with students in ways that the professor might not be able to (*i.e.*, through listening to lots of student questions during class). Where professors give lectures and provide information, LAs provide support in the form of probing student knowledge through various questioning strategies. In this way, their preparation does not entail a generic dispensing of content, but one that is responsive to questions from students.

Following the utterance above, Charlie continues to reflect on his role. Charlie contrasts his goal—to be fully prepared to answer any common student question—to the reality of the LA classroom experience, and how that informs his ideas on LA efficacy:

> *But that being said, that's not something that you could always have. You're not always prepared for what someone's going to ask you. So I wouldn't want to say that I'm less effective when I feel less prepared, because I think part of being a Learning Assistant is being able to still have that student perspective, and it's like some of this material you're not going to be as familiar with as other and working through that with students. And even if I feel like I don't have the correct answer, maybe I'm almost more effective when I'm a little less prepared, because I can put myself more*

in the mindset of a student and work through them with it. So it's kind of there's these two extremes, but I feel like I'm effective in different ways of both ends in terms of preparedness.

Charlie articulates how he navigates these two positions (*i.e.*, teacher and peer). He seems to say that he can be equally effective when unprepared because he is able to better experience the material from the point of view of the student ("maybe I'm almost most effective when I'm a little less prepared, because I can put myself more in the mindset of a student"). Notably, Charlie says this is "part of being a Learning Assistant." He does not state this is how he personally would prefer to operate in a classroom; instead, it is somehow inherent to the position of a Learning Assistant. This indicates this is part of how the role as an LA is part of his epistemology.

Further along in the interview, Charlies continues to elaborate on his existence in a superposition of two extreme states:

I think I'll be more effective in helping a student if my only goal is to have them to reach the correct answer. If I've prepared beforehand and know what kinds of questions they might have, it's probably more likely that they'll feel like they got the answer from me, and maybe I'll be a little bit quicker to return their question with other questions, to understand their understanding. Whereas on the other hand, I'm going to feel a lot more nervous, so that might take away a little bit from my performance if I feel I don't have a good understanding of what's going on. But I'll be more inclined to continue to ask questions back to them rather than explaining. It's not something that I can fall back on as an explanation if I personally feel like I don't have a concrete explanation to give them. So it really is two ends.

Here, Charlie is more explicit in how his epistemology informs the duality of his role. He states that *if* his goal were simply to get the students to restate a correct answer (a goal that would be described by an Absolute epistemology), then adequate preparation is key. This is *not* because his preparation will give him better answers, but because it will make it more likely that he will "return their question with other questions, to understand their understanding." So, the preparation is not in service of knowing the answer better so that he can simply provide it to a student, but so that he can agilely respond and keep the discussion student-led. This is in sharp contrast to the role of the instructor within an Absolute way of knowing, who is supposed to dispense knowledge. Charlie concludes by re-emphasizing that his unique role as an LA "really is two ends" which include being neither instructor, nor peer, but also combining elements of both in ways that lead to a unique classroom role. This quote also shows how students can often express ideas that are both Absolute and Transitional.

Similarly, Wyatt describes that he sees his role, based on "co-creation of knowledge" is distinct from other classroom or learning activities.

I think there's like a huge resistance for students to be involved in group work and do this co-creation of knowledge thing. And like I am seeing it as really valuable, and so I think that they're the activities that students that– we engage with these students in. We need this to be well thought out and purposeful. You can't just throw students into the group work and expect that to be...I think that's different. Group work and Learning Assistant activities, I think, this is a bit different. –Wyatt

When the interviewer asks Wyatt to elaborate on the distinction, Wyatt also espouses both Absolute and Transitional ideas while contextualizing his role in the learning process. In this quote, the LA juxtaposes "group work" and "Learning Assistant" (that is, group work activities facilitated by LAs) by analyzing the activity itself, here a sensemaking activity from the *Tutorials in Introductory Physics.*[21].

> *I think that learning assistant group work is, like, pointing out misconceptions about mechanics concepts, I guess. Because, going through the physics learning assistant course, I found that the tutorial's really exposed lots of things I thought I knew about physics and that I didn't. And, being able to work with group meets and talk through with like learning assistants who were also college students, I thought that that was really valuable, and I built relationships with those students that I was in a group with. And, I just felt that that was a like meaningful experience, and I also feel like I understand those concepts better than like in physics courses that I didn't have learning assistance or group work or that kind of group work. I just find it to be very meaningful, and I think if it's done in an intentional way, can you be like...It can be really helpful and yeah.*

On the one hand, Wyatt seems to believe that his role is composed at "pointing out misconceptions," which aligned with an Absolute vision near to the role of instructor. However, the key difference here is that he "built relationships with those students that I was in a group with." In the Baxter Magolda framework, building relationships in order to better promote conceptual understanding of material lies neither with peers or instructors. Instructors may establish rapport with their students, and peers may reinforce learning by offering different perspectives or generally create a good atmosphere for learning (see Table 1). Here, the critical component for Wyatt is existing in both spaces simultaneously, which he ultimately interprets as the most "meaningful" aspect of his role. In more solidly Transitional knowers, interestingly, the orthogonality is conserved. What changes is what the purpose of the orthogonality. In the following quote from a reflection prompt, Learning Assistant Finley describes this challenge.

> *The biggest challenge in the LA classroom the past two weeks has been finding the right tone to take with the students. I'm a friendly, open, and casual person by nature, especially towards people my own age. Being placed in a position of semi-authority as an LA requires me to balance treating the students as peers/friends, and treating them in a more professional manner, so they take me seriously when I try to guide them through their work. It's a difficult balance to strike; if I am too detached and professional, the students aren't as comfortable showing vulnerability and asking questions when they are confused, but if I am too friendly and casual, it could distract them from the work that they're supposed to be doing in class. –Finley*

In this selection from a reflective journal entry, Finley discuss how their unique position as an LA in the classroom can create challenges. In this journal entry, they describe a challenge of their role being neither a peer nor instructor. It is clear they are trying to strike a "balance." But what is the nature of that balance? Interestingly, they do not discuss balance in terms of what instructional materials to provide, or which questions to ask at what times, which would be the bulk of their training. Instead, Finley discusses striking a balance within the context of their more

interpersonal connection with their students ("if I am too friendly and casual..."). Finley goes on to describe that this balance is in fact for the purposes of instruction ("it could distract them from the work they're supposed to be doing in class"), indicating an epistemology in which knowledge is generated partly through interpersonal connections. As such, we coded this quote as "Transitional." Further, Finley strives to have the students "take [them] seriously when [they try] to guide them [the students] through their work." Again, we see that Finley doesn't strive for an authority position from which to dispense knowledge; instead, they see that being "comfortable showing vulnerability" is a critical aspect of learning, as it facilitates the students "asking questions when they are confused." This more interpersonal approach to teaching leans more into a Transitional epistemology, and further illuminates how the LA role exists in some space that is really less of a combination or intersection and more of a superposition of various roles.

Finley continues by answering what they do to address his major challenges:

> *Working through this challenge for every class changes my approach as an LA from quarter to quarter. Every time I work through it, though, the biggest takeaway is to not compromise my own personality for the sake of seeming more casual or more professional in the classroom. Whether I swing more casual or more professional, I always have to be authentic to my own personality, or else I won't connect at all to the students, and I won't be able to help them learn the material.*

Despite the challenges of navigating the role of the LA, Finley states they must remain "authentic to my own personality" in order to be the best LA he can.

In the Transitional epistemological stance, the role of peers is to "'provide active exchanges" and the role of the instructor is to "employ methods aimed at understanding [14]." In our operationalization, the *Role of the LA* functions as something altogether different, where the focus is on listening and understanding students and attending to the interpersonal dimensions of learning experiences. The LAs therefore fill a unique role that is neither that of a peer or an instructor. Instead, they focus, at least in part, as shown by Finley, on how they are perceived by students in class and how to maintain authenticity while carrying more content knowledge than the students they are supporting.

3.1 Limitations

One limitation of our study is related to the sample population we interviewed to operationalize the Role of the LA code. Baxter Magolda's original model, including beliefs about the role of Instructors and Evaluation, was developed via interviews with college students. That is, while she did not develop the operationalize the *Role of Instructors* through interviews with Instructors, we did operationalize this new role via interviews with LAs themselves. However, given that part of LA training involves directly reflecting on their role, we believe they can offer unique insight into how LA experiences might encourage epistemological growth. Nonetheless, future research should explore student perceptions of the LAs in their classrooms to triangulate and add to our current findings.

In Baxter-Magolda's work, she discusses how gendered patterns of knowing arose in all ways of knowing categories. Given our small sample study and limited longitudinal analysis, we do not

make strong claims if we observed similar or disparate gendered patterns.

Another limitation of our study is that while we did observe some instances of Independent and Contextual ways of knowing, we did not observe any LAs that we would characterize as consistently Independent or Contextual knowers. As noted above, Baxter Magolda's model actually encompasses four stages of epistemological development in college students that spans from Absolute to Contextual. In her model many college students can spend their first three years in the Absolute or Transitional stages, and that is the population from which we primarily sampled. By sampling from the LA seminar, we necessarily selected for LAs who were themselves in their second or third year of their undergraduate work and thus more likely to espouse beliefs consistent with Absolute and Transitional epistemologies. Future work will follow up with more experienced LAs to examine if or how their own epistemologies might change or develop over time.

4 Summary

In this study, we interviewed and surveyed Learning Assistants (LAs) about their experiences and challenges in the classroom. We analyzed this text for findings on their epistemological orientation towards their role. Our framework was the Epistemological Reflection Model which outlines both *ways of knowing* (epistemological development stages) and *domains* (salient elements of the learning process, including roles of instructors, peers, and students)[14]. We found that in both Absolute and Transitional ways of knowing, the LAs discuss the challenge of simultaneously drawing from all three roles (instructor, student, and peer) in carrying out their duties, but also how those three roles do not necessarily capture the critical or essential ways they engage with learners.

The difference between them is the ends to which their role is achieved in a classroom. If it were the case that Absolute knowers perceive their role as an LA to be near an instructor (provide direct instruction) whereas Transitional knowers perceived their roles as better aligned with peers (provide active exchanges), there might not be a need to further operationalize the role of the LA. However, it is evident in our data that, for both types of knowers, their role is conceptualized as, ideally, a superposition of instructor, peer, and student, therein existing orthogonally to the typical classroom hierarchy. In operationalizing the *Role of the LA*, our findings can help educators make sense of the unique role LAs play in STEM classroom and the ways their experiences might help promote epistemological change over time. This extension of the Baxter-Magolda Epistemological Reflection model to include LAs would aid in further improving preparation for LAs, and by extension, student course outcomes.

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