

Analysis of Learning Assistants' Views of Teaching and Learning

Kara E. Gray and Valerie K. Otero

School of Education University of Colorado – Boulder, 249 UCB, Boulder, CO 80309

Abstract. For several years the University of Colorado has been using undergraduate Learning Assistants (LAs) in their introductory science and math courses. While the LAs have teaching duties very similar to graduate Teaching Assistants (TAs), first year LAs are also required to take an education course focused on teaching methods. The purpose of this course is to first help LAs improve their teaching in the university classrooms and to encourage some of the LAs to consider careers as K-12 science teachers. Throughout the semester LAs are asked to reflect on their learning about teaching and on the applications of these concepts to their current teaching experience. This paper will present an analysis of this learning experience from the perspective of the LAs. The paper will also present how LAs evolve as teachers and as learners throughout this experience.

Keywords: Physics education, teaching, teacher preparation

PACS: 01.40.Di, 01.40.Fk, 01.40.gb, 01.40.J-

INTRODUCTION

The STEM Colorado Learning Assistant (LA) program [1] began at the University of Colorado in 2003. The program has been implemented in seven science, math, and engineering departments across the university and is currently being replicated at six four-year institutions which have received federal funding for this effort. Undergraduate LAs are talented students hired to assist other students in courses they previously completed by helping instructors make these courses more student-centered and interactive.

Through the LA experience, LAs engaged in the development of content knowledge, the development of pedagogical knowledge, and practice. First, LAs furthered their content understanding in weekly meetings with the lead instructor of the course. In these meetings they planned for the upcoming week, reviewed the upcoming content, reflected on the previous week, and analyzed assessment data. Second, LAs developed their pedagogical knowledge through a weekly science and mathematics education seminar, which was co-taught by an education faculty member and a high school physics teacher. The class was attended by LAs from all departments and was organized around a series of articles which LAs read and then discussed. Topics in the seminar included questioning, learning theories, multiple intelligences, metacognition, student epistemology, argumentation,

formative assessment, and the nature of science. LAs were required to submit weekly reading reflections, weekly teaching reflections, two article reports, and a final project that summarized how they synthesized what they learned through the LA experience. Finally, LAs engaged in practice as they led learning teams of approximately 4 students as they collected and analyzed data and constructed explanatory models of phenomena. This three-pronged experience, as shown in Fig 1, provided a rich learning experience leading to the development of pedagogical content knowledge.

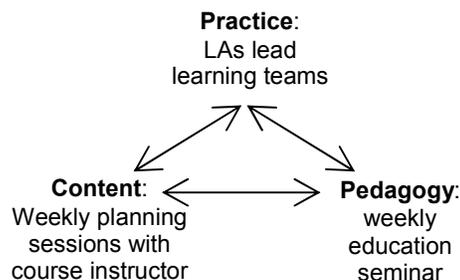


FIGURE 1. The LA learning experience.

The main focus of the LA experience was helping LAs learn the formative assessment process whereby the instructor elicits and responds to students' evolving knowledge [2, 3]. Central to this process of formative assessment was LAs questioning their students to find

out what they were thinking at a given point in time. This would determine the response that was provided by the LAs. Other roles of instructor questioning were helping students to reason through a logical argument and simply to help students articulate and defend their ideas to other members of their group.

LAs have been used in the physics department for five years. They have worked in several different courses using various models that engage them in content, pedagogy, and practice as described above. The physics LAs considered in this study all served as LAs in the two semester sequence of calculus-based physics. They co-lead weekly Tutorial sessions (with a graduate TA) attended by approximately thirty students. During these sessions they helped students as they worked in groups on the Tutorials for Introductory Physics [4].

In the Tutorial setting, the main opportunity for LAs to engage in formative assessment lay in their opportunity to question students through informal interactions during the weekly tutorial. In this paper, we investigated how LAs view their role, specifically in terms of questioning.

METHOD

The research reported here contains a sample of LAs from the Spring 2008 semester of the program. Ten of the thirty-five LAs enrolled in the LA seminar during this semester were working in the physics department and these ten are the focus of the study reported here. These physics LAs were evenly split among physics and engineering majors. Six of the ten worked in the first semester mechanics course and four worked in the second semester electricity and magnetism course. This group of LAs included freshmen, sophomores, and juniors.

One of the requirements for the weekly education seminar was that the LAs fill out an online teaching reflection each week. These online reflections included approximately six questions which asked LAs about their goals for the week, conceptual issues they noticed, the status of group work, types of interactions they had with students, and what they felt worked and did not work in their instruction. The lead instructors for the course read a sample of these reflections each week before class.

We analyzed the teaching reflections for instances in which LAs implicitly or explicitly discussed the questioning of students. We further analyzed this subset of data (Questioning Events) for common themes. We then developed categories based on these common trends in LAs' stated reasons for questioning their students. The final categorization scheme emerged through this iterative process of constant

comparison. Throughout the process we revised and clarified the definition of each category.

RESULTS

Instances of LAs discussing questioning were divided into seven different categories. The instances of each LA mentioning a category were then counted and broken down by week. The results discussed here will focus only on the beginning and end of the semester so that we can consider the changes that may have occurred. In the following section two types of results are presented, the categories themselves and the frequency data.

Result 1: LAs views of Questioning

Each of the seven categories that emerged from the data are listed below, followed by a prototypical example for each.

Get student to answer. This category contains instances where the LA described leading students to the correct answer by asking them guiding questions. This can also be referred to as the Socratic method.

“One group was really confused about how there could be a positive acceleration while the object was slowing down, so I asked them several questions like “what is the difference between speed and velocity”; to help guide them to the conclusion that the direction of the vector quantities as well as their magnitudes matter. It took about five minutes, but they got it.”

- LA8, Week 1

Not giving right answer. Sometimes the LAs had trouble asking questions instead of giving answers. Other times the LA described frustrations that students were having with the LA's use of this technique.

“What did NOT work was when I would jump in at what was the right answer, which I really wanted to do a lot. It seemed like this wasn't working because students stopped thinking about why it was right and what the solution even meant and when I later asked a question that was similar they didn't have the ability to think about how to arrive at a similar solution.”

- LA5, Week 1

Encourage (conceptual) thinking. LAs also asked students questions to encourage them to think about their answer or thinking. The purpose of the

questioning described in this category was not to clarify the students' thinking for the LA, but for the students to clarify their reasoning for their own understanding.

"It worked well for me to circulate and ask students questions about their motors and why they were running. I also tried to ask questions that had the students focus on why there might be an emf in a loop but no current."

- LA2, Week 12

Encourage group discussion. Because students were not used to the format of Tutorials, they often needed encouragement to share their ideas with each other and to work together on the questions. Many LAs used questions to start the group discussions.

"... in some classes it seemed like no one was participating. However when I opened up a group by asking them where they were at, and asking open questions, it seemed like most of the times the groups would start conversing. I think next week I'll just continue to engage groups and ask questions."

- LA5, Week 2

Understand student thinking (formative assessment). In this category the LA described situations where she asked a student questions to understand what the student was thinking. Once the LA understood what the student was thinking she usually continued asking the student more questions to influence the students' thinking. In order for a reflection to fit into this category the LA must explicitly mention using the information gained from the student's response to influence her next actions.

"I learned how important it is to listen to what reasoning the students are using to find their answers. Based off of their thoughts, you can catch a glimpse of the way that that specific student thinks and adjust your approach to suit him/her. It's amazing how many different ways students can think about one problem."

- LA8, Week 2

Work on questioning. In their reflections the LAs often described things they wanted to work on over the semester or in the upcoming week.

"Next time I am going to work on asking more open ended questions and ask questions that [involve comprehension], analysis, and synthesis."

-LA4, Week 2

Other. Reflections that fell into this category discussed the questioning of students but the purpose of asking the questions was not clear so it couldn't be put into other categories.

"When I went from table to table I went around the table asking everyone something."

-LA4, Week 2

Six of the seven categories listed above provide a window into how LAs were reflecting on their roles and how questioning played into this thinking. These six emergent categories suggest four roles that the LAs play in the Tutorial classroom setting. These roles are: facilitating the acquisition of physics content, facilitating the students' sense-making process, shaping the learning environment, and working on their own professional growth and development. These roles are listed in Table 1, along with the categories in which they are manifest.

TABLE 1. LAs' self-perceived roles

Roles	Categories
Facilitating physics content	Get student to answer
	Understand student thinking
Facilitating students' sense-making	Encourage (conceptual) thinking
	Not give right answer
Shaping the learning environment	Encourage group discussion
Professional growth	Work on questioning

Result 2: Frequency Analysis

Table 2 shows the frequency counts associated with each code. The count in each cell represents the number of Physics LAs (not the number of times this code was referenced by LAs) who made a comment that week which fit into the given category. An LA could be counted in multiple categories for a week (they mentioned several purposes for questioning) but were not counted multiple times in the same category. A count of LAs and not number of references was used because some of the LAs mentioned a situation or issue multiple times in a single reflection which inaccurately inflated a count of references.

As shown in Table 2, the physics LAs appear to have tapered off in reporting questioning as the semester progressed. As the semester progressed they began to increasingly discuss situations in which they explained concepts to students. We have two conflicting explanations for this. First, the LA seminar began with a discussion of univocal and dialogic teaching and open and closed questions. The second week LAs discussed Bloom's taxonomy and its

applications to the types of questions they could ask students. After these two weeks, LAs moved on to other topics in education such as metacognition, epistemology, conceptual understanding, and assessment. It is possible that as the course stopped focusing on questioning techniques, LAs stopped focusing on questioning in their practice, or at least in their weekly reflections.

TABLE 2. Questioning Categories

Categories	Weeks					All
	1	2	3	12	13	
Get student to answer	4	3	4	0	1	12
Not giving right answer	2	1	0	1	0	4
Encourage thinking	3	1	3	1	1	9
Encourage group discussion	2	4	2	0	0	8
Understand student thinking	1	2	3	1	0	7
Work on questioning	1	7	1	1	0	10
Other	1	3	0	1	1	6
All	14	21	13	5	3	56

It is possible that when the LAs were not focusing on questioning students, they reverted back to the more familiar style of teaching which means, to them, simply explaining the answer to students. If this was the case, then the LA seminar may need to be adjusted so that questioning is a consistent theme in the readings and discussions throughout the semester. This explanation can be tested by changing the weekly education seminar so that questioning techniques are discussed throughout the entire semester.

A second possible explanation is that the LAs stopped discussing questioning in their reflections because it became such an engrained part of their teaching styles they did not notice it as much at the end of the semester as they did at the beginning. Instead, for these LAs, to explain a concept meant to ask students questions to help them clarify their thinking. This explanation is supported by the following comment made by LA2 during the week two reflections, “I had some difficulty explaining one of the tutorial questions – or rather asking questions that led students to the answer.” For this LA, she was still aware of what she meant by “explaining”; if other LAs were using a similar definition of “explaining” they may not have been conscious of their unconventional use of the word. It is also not clear whether such unconscious adoption of formative feedback is a positive thing in novice teachers. The LA seminar may need to be adjusted to make this adoption once again visible to the LAs.

Based on the results shown above most of the physics LAs seemed to be focused on using questioning to lead students to the right answer (12

instances occurred during the five weeks discussed above). Yet, they were not as focused on attempting first to understand what students were thinking (seven instances occurred during the five weeks discussed above) according to their reflection reports. There are several possible reasons for this. First, formative assessment is challenging even for experienced teachers. This is the first teaching experience for most LAs, so they have not yet mastered the skill of eliciting and responding to students’ ideas. It is possible that the LAs were not asking students to explain their reasoning because they felt they were getting enough information by reading the students’ written answer in the tutorial workbook. It is also possible that LAs were not explicitly reflecting on using formative feedback because it became such a natural step in their questioning process that it was unconscious to them. Considering how difficult formative assessment is for many teachers, this explanation is unlikely.

CONCLUSIONS

Questioning is a large part of the LAs role and it begins as a major part of their thinking about their own teaching. Yet, this focus typically appears to be on getting students to the right answer rather than on understanding where students currently are in their thinking. This focus on questioning also appears to taper off as the semester moves on as LAs learn about other ideas in education. While this is one way of interpreting the reflections, there are also several other interpretations which are possible. Future research will include observing and interviewing LAs to understand better what they are doing in practice. This project will also be expanded to LAs in other departments who work with students in very different contexts from the physics Tutorials. This expanded project will consider what common concerns LAs have about questioning which extend beyond context as well as the effects context has on the LA teaching and learning experience.

REFERENCES

1. Otero, V., Finkelstein, N., Pollock, S., and McCray, R., *Science* **313**(5786), 445-446 (2006).
2. Otero, V., and Nathan, M., *Journal of Research in Science Teaching* **45** (4), 497-523 (2008).
3. Black, P., and William, D., *Assessment in Education* **5** (1), 7-74 (1998).
4. McDermott, L.C., Shaffer, P.S., and the Physics Education Group *Tutorials in Introductory Physics*, Upper Saddle River, NJ: Prentice Hall, 2002.