Student-instructor questions in the active learning physics classroom:

Comparing perceived and actual questions across teaching roles

Newt Gordon-Rein, Aliyah Weiss, and Selasie Mortey

Department of Physics, Tufts University

ED 0020: Learning and Teaching in STEM: A Seminar for Learning Assistants

Dr. Vesal Dini

15 December 2023

Introduction

With this research project, we wanted to investigate something that we interacted with daily as LAs. We landed on questions in particular because they seemed central to the active teaching style: as LAs, we favor asking questions over giving answers to promote student learning (e.g. if a student asks "Am I doing this right?" we would say "Well, how did you conceptualize the problem?" rather than giving a simple "Yes" or "No" response). We began thinking about the various student teaching roles in our section: Learning Assistants (LAs), Section Coaches (SCs), and Lab TAs (LTAs). We wondered whether, in alignment with their different roles and contexts, there was a difference in the ways they interacted with students, and with question asking practices in particular. We wanted to know whether the students perceived these possible discrepancies and also whether they empirically existed. Thus, our research questions were twofold: Do student and instructor questions differ between environments in Physics 11? and Is the difference perceptive or reflective between the three instructional roles?

Literature review

As we were a team of three, we analyzed three existing research papers to prepare for this process. The first was "Enhancing learning? A comparison of teacher and teaching assistant interactions with pupils" (2010) by Christie M. Rubie-Davies et al., which found that TAs were more familiar with students and gave more attention to "low-ability" (as they phrased it) students and those with special needs where professors had a more distanced and general approach. Rubie-Davies et al. also noted that TAs answered more questions while professors spoke more conceptually. We did not examine the professor role, and neither LAs, nor SCs, nor LTAs exactly

fall into the category of a traditional "TA," but the dimensions of "conceptual explanation" and "question answering" helped us to determine categories when we were coding student survey responses about their expectations for each student teaching role.

The second paper, "Investigating learning assistants' use of questioning in online courses about introductory physics" (2023) by Jianlan Wang et al. presented data about the types of questions LAs ask gathered from LA-student interactions. They devised a scheme for evaluating the effectiveness of each question in promoting student learning as well as categorizing the questions as "probing"—a temperature check to see how students feel or "guiding"—expanding questions which moved discussions along. Since we were only interested in categorizing questions, not evaluating them, the guiding/probing part of their analysis helped us to define some of the categories that we would use to code the expected and actual questions from our data sets.

The final paper, "From teaching assistants to learning assistants—lessons learned from learning assistant training at Excited" (2020) by Madeline Lorås included detailed descriptions of different types of LAs which were somewhat analogous to our student teaching roles. This analysis also helped us to understand student survey responses about how they would define each role. It also lent some insight into our final conclusion that the teaching process for active learning instructors might cause their question asking strategies to all follow a similar pattern.

Methods

In order to gather data to see the students' perceived differences between the three student instructional roles, we conducted an anonymous survey for a section of Physics 11 students. This survey was conducted for the Physics 11 Section 1 students (18 years old and

above and with their consent). Our survey had the following questions (we use LA, SC, and LTA abbreviations here, but the role names were written out in the actual survey):

1. What do you think a Physics 11 LA's role is?

2. What is a question you think an LA would ask you?

3. What is a question you think you would ask an LA?

4. What do you think a Physics 11 SC's role is?

5. What is a question you think an SC would ask you?

6. What is a question you think you would ask an SC?

7. What do you think a Physics 11 LTA's role is?

8. What is a question you think an LTA would ask you?

9. What is a question you think you would ask an LTA?

We communicated that all questions were optional, the survey would not affect their grade in the course, and their responses would not be identifiable to the professor. There were a total of 83 student responses. We used the word "think" for each question with the aim of emphasizing our interest in their perception of what happens and to show that we weren't asking them to recount or remember what actually happens in class. We stressed perception because of the goal stated earlier: "*is the difference perceptive or reflective*".

Transcripts / Recordings of student and role interactions were provided by 2 LAs, 2 SCs, and 2 LTAs. We informed students that recordings would be kept anonymous, all names would be recorded as pseudonyms, and that recordings would be deleted after transcripts were created. We used the six transcripts to extract the questions posed by students or a role. All other dialogue in the transcripts was deleted. The purpose of the transcript was to gather information on real life interactions.

We organized this data by loading all survey responses and transcript questions into a spreadsheet. Keeping each survey question as a separate column, we tagged each response with at least one marker from our coding schemes. To maintain consistency, we divided the data such that one group member was responsible for the questions concerning each teaching role, and that group member analyzed all the data from the questions about that role; after, we swapped sections and re-coded them to ensure that the categorization done by each person were agreed on by everyone. When compiling the data, we grouped questions 1, 4, and 7 to focus specifically on student perception of what a specific instructional team role is responsible for.

Using the same methods, we analyzed the remaining questions and grouped those in our analysis to focus specifically on student perceptions of what they ask and are asked. The data on Role Expectations needed to be sorted based on expectations, and the data on questions being asked (survey and transcript) needed to be sorted based on type of question, so we used the two following coding schemes:

Coding Chart: Role Expectations (for survey questions 1, 4, 7)

Expectation	Definition	Example
Facilitation of Discussion	Student expects Role to participate in discussions / involve all students	"To join group discussions and ask us questions to keep our discussion going."
Teach / Give info / Lecture	Student expects Role to give information about topics in lecture format / recite information	"Help reiterate or explain unfamiliar concepts of ideas that we still have questions on"
Deepen Understanding	Student expects Role to create a student led space for exploring information	"Making us consider something new"
Provide Answers	Student expects Role to give / confirm answers	"Encourage discussion and eventually give the right answer"
Miscellaneous	Anything else	"I don't know what a Section Coach is"

Coding Chart: Types of Questions (for survey questions 2, 3, 5, 6, 8, 9)

Type of Question	Definition	Example
Conceptual Question (CQ)	Asking about a concept	"Can you explain this concept?"
Technical Question (TQ)	Asking a specific question relating to content	"What data points are you collecting?"
Interrogative Question (IQ)	Asking to understand reasoning	"What is your reasoning?"
Expanding Question (EQ)	Making a connection to another topic / idea	"What if friction wasn't negligible?"
Probing Question (PQ)	Figuring out where people are at (temperature check)	"Where are we?"
Miscellaneous (misc.)	Anything else	"Same as LA"

This data was then gathered into tables that totaled the number of times each coding criterion was tagged for each role in each survey question or transcript genre (questions asked or received), and we synthesized them into the graphs for the presentation. The tables are provided in the next section, and the graphs can be found in the Appendix.

Results

The following tables show our synthesized data groups for each given category.

Student Survey Questions 1, 4, and 7: "What do you think a Physics 11 [LA/SC/LTA]'s role is?"

Perceived Roles	Facilitation of Discussion	Teach/Give Info/Lecture	Deepen understanding	Provide Answers	misc
LA	54	8	16	4	8
SC	21	27	21	6	14
LTA	21	26	21	1	5

Table 1: LA, SC, and LTA perceived roles

Student Survey Questions 2, 5, and 8: "What is a question you think a(n) [LA/SC/LTA] would ask you?"

Expected Questions	Conceptual Question	Technical Question	Interrogative Question	Expanding Question	Probing Question	misc
LA	3	5	58	13	7	2
SC	2	9	28	11	14	12
LTA	8	24	28	16	4	4

Table 2: Questions students say LAs, SCs, and LTAs ask

Student Survey Questions 3, 6, and 9: "What is a question you think you would ask a(n) [LA/SC/LTA]?"

Expected Questions	Conceptual Question	Technical Question	Interrogative Question	Expanding Question	Probing Question	misc
LA	19	16	15	3	21	4
SC	4	31	6	7	16	11
LTA	1	58	0	9	5	1

Table 3: Questions students say they ask LAs, SCs, and LTAs

Recorded Transcript Data: Questions Instructors Ask Students

Questions	Conceptual Question	Technical Question	Interrogative Question	Expanding Question	Probing Question	misc
LA	1	1	2	3	6	0
SC	2	0	3	3	7	1
LTA	1	0	3	2	4	0

Table 4: Questions LAs, SCs, and LTAs asked students

Recorded Transcript Data: Questions Students Ask Instructors

Questions	Conceptual Question	Technical Question	Interrogative Question	Expanding Question	Probing Question	misc
LA	0	2	0	0	0	1
SC	2	0	4	1	1	0
LTA	0	0	1	0	0	1

Table 5: QUestions students asked LAs, SCs, and LTAs

For bar graphs synthesizing the relative quantities described in each table, please see the

Appendix.

Table 1 (fig. 1), shows the majority of students in the class see LAs as facilitators; they expect LAs to guide them during discussions and are willing to invite them into their in-class discussions. Students feel that the role of the SCs and LAs were more evenly distributed between facilitating discussions and more direct instruction.

Table 2 (fig. 2) shows that students think LAs primarily ask them to explain their answers or reasoning. Students also most often think that SCs and LTAs ask about reasoning, although SCs are seen as asking more questions that gauge student confidence, prompt other lines of thought, and recall didactic information, while LTAs are seen as asking didactic questions almost as much as reasoning ones, and prompt other lines of thought more than the other options.

Table 3 (fig. 3), shows that most students report asking LTAs questions about specific issues that come up in class. Most students said that they would ask SCs these same technical questions or ask about how they are doing. They report asking LAs about concepts, in-class issues, how they are doing with a problem, or about their processes of solving the questions.

Table 4 (fig. 4) shows that general checking-in questions are the most prevalent across all teaching roles. The LAs in particular asked less about reasoning than student expectation data might suggest. Instead, LAs and SCs asked probing questions with the highest frequency, followed by the more actively instructional interrogative and expanding questions. In terms of content, LTAs asked notably more open-ended questions than students seemed to expect.

The data set from Table 5 (fig. 5), with a total of 13 data points including 2 miscellaneous ones, is so small that we agreed its findings may be unreliable. In SC interactions, it did seem like these questions were more process- than answer-driven. In the recordings we received, students asked questions much less frequently than instructors.

Discussion

Our research questions ask: Do student and instructor questions differ between environments in Physics 11? and Is this difference perceptive or reflective? We use the word "environment" (1) because each student instructional role engages with the students in different places and at different stages of their learning (LAs during lecture, SCs during recitation, LTAs during lab class) and (2) because the student-instructor interaction does not exist in isolation, so we have to consider when posting conclusions that the instructor role is not the only difference between the scenarios we are analyzing.

For example, the Physics 11 students were told about the structure of the course; active learning was discussed in the classroom, and the students were even encouraged to study it as homework. We conducted our research at the end of the semester, so months' worth of this information and experience funneled into the students' perception of the different instructional roles. We found that 60% of students thought an LA's role was to facilitate discussion, and 17.8% thought it was to deepen understanding. In contrast, SCs were identified by almost equal percentages of students as facilitators, lecturers, and resources to deepen understanding, and LTAs had the same top responses, but with slightly more emphasis on lecturing and significantly less miscellany. It seems that at least for LAs and LTAs, the students report roles that closely match the active learning pedagogy, so it is difficult to disentangle their knowledge about the active learning environment from their lived experience. That said, we did find some interesting trends in the data as it pertains to each role and its associated environment.

Our results indicate that students do perceive different instructional roles as favoring different types of questions. Table 2 shows that 65.9% of questions students think LAs ask are Interrogative Questions (IQs), with the next most popular category being Expanding Questions

(EQs) at 14.8%. So, students seem to think of LAs as asking about the problem solving process, prompting conversation about how students get to their ideas and sometimes following up by asking students to apply that reasoning to other, related concepts. In all, this seems like an active discussion role.

The SC data is less focused, with 36.8% IQs, 18.4% Probing Questions (PQs), 15.8% misc., 14.5% EQs, and 11.8% Technical Questions (TCs). So while SCs are still considered interested in the problem solving process of students, including specific details about the content being discussed, they also are seen as checking in with students, and prompting other lines of thought. The significant "misc." category of perceived SC questions is mostly made up of overly obtuse examples (e.g. "A physics problem") or "I don't know" answers. So it seems as if students see SCs as asking a more holistic range of questions, perhaps meaning that SCs are well-rounded teachers in the eyes of the students.

LTA data produced three popular responses, namely that 33.3% of the time, students thought LTAs asked IQs, 28.6% TCs, and 19% ECs. By a small margin, LTAs are also most often perceived as asking about the thinking process, but they are also significantly interested in specific concepts and promoting inquiry in their students. LTAs seem to ask questions that include process, but are backed by concept and exploration.

As far as our data is concerned, it is clear that students perceive different distributions of each kind of question being asked in each environment. But how does this data compare to the real-world transcripts we collected?

We have described in Table 4 the actual, behavioral differences between the questions that each role asks, and we have seen that they match each other much more closely than the student expectation data would suggest. In fact, PCs were the most prevalent questions asked by

every role (LA=46.2%, SC=43.8%, LTA=40%), followed by EQs (LA=23.1%, SC=18.8%, LTA=20%) or IQs (LA=15.4%, SC=18.8%, LTA=30%). The only other category with more than one data point was SCs with a 12.5% distribution of CQs. These percentages seemed to make intuitive sense. In a classroom based around student thinking, instructors should check in first, engage with students about reasoning, then delve into more expansive or specific topics. If this is what happens across the three different learning environments, it points to a cohesive philosophy of practice adopted by LAs, SCs, and LTAs alike. From this relatively matched distribution, we reached conclusions about both of our research questions. According to our data, there is no evidence for a perceptive difference between the question asking behaviors of different instructional roles. There is, however, a definite reflective difference where the students expect different questions from different roles.

Moving on to questions students think they ask each role, Table 3 shows us that students think they ask LAs PQs 26.9%of the time, CQs 24.4%, TQs 20.5%, and IQs 19%. This means that students expect to check in with LAs to see how they are doing, as well as reaching out for guidance on general and specific concepts and strategies for solving problems. They supposedly use the LAs as sounding boards and general toolbox resources.

Students report that they ask SCs TQs 41.3% of the time and PQs 21.3% of the time, once again with a significant misc. factor of 14.7%. This shows that students mostly expect to ask SCs about specific, detailed information, but still significantly seek reassurance that they are on the right track. The misc category here is made up of answers like "Why is Physics" and "it varies" or, again, "I don't know". It is interesting that this blurriness surrounding SCs extends to questions asked in both directions.

The LTA data is extremely focused for this prompt, with 78.4% of responses indicating

that students would ask LTAs TCs. This makes sense when you consider that they are experimenting in the lab–it seems that students see themselves as seeking answers to specific, often logistical problems from their LTAs.

Our inconclusive results for the student-asked questions in recorded transcripts meant that we could not draw any conclusions about perceptive differences between questions for different roles, but the survey results show that these, too, have a reflective difference. Our research was conducted at the end of the semester, so it is possible that this reflective difference was the result of experience with each role, information given to them about the structure of the class, or some combination of the two. Given a large enough data set, it would have been especially interesting to see whether the students' predictions for their own behavior was any more accurate than for the instructors.

Unexpected Problems

As with any research, unexpected problems do occur. When the data collection process began, we ran into some logistical problems gathering voice recordings. This research occurred during the last month of the semester, which is the busiest time for all students and teachers. It was hard to pin down the instructional team to receive transcript and/or audio recordings from them. This meant the data size we ended up working with was small, and thus hard to analyze. The small sample size made the data more susceptible to our own inevitably biased analysis and conclusions. The circumstances of the recordings also may have led to a biased sample: the instructors were asked to record interactions, so they chose which interactions ended up in our data set, and all parties knew they were being recorded, both of which may have led to a sense of evaluation and data skewed toward a more idealized active learning interaction. In the data, we

noticed that instructors asked far more questions than students did. We speculated that this could be a response to the student-led active learning thought process, but it is equally likely that this was due to the circumstances of the recordings. Beyond a sense of surveillance, our direct request to instructors meant they were most likely to record when actively going up to students and speaking with them, eliminating the anecdotally reported case where a student comes up to the instructor or any other situation.

We originally planned to collect survey information from the instructional team members as well as the students. This survey included prompts nearly identical to the student survey: participants were asked to confirm that they were 18 and willing to participate in research, then to select their teaching role, then depending on that selection, short answer prompts asked "How would you describe your role as [role]?" "What is a question you think a student would ask you?" and "What is a question you think you would ask a student?" Our goal was to analyze these responses and compare the instructional team's perception of questions to the students' perception. However, after weeks of repeated appeals for the instructors to respond, we were left with 5 responses from Lab TAs, 1 from Learning Assistants, and 0 from Section Coaches. Unfortunately, this meant the instructor survey had to be scrapped. We slightly altered the questions we were trying to answer with our research to focus more on student perception and how their perceptions might ultimately impact the interactions they have with teaching staff.

The structure of our surveys may have unintentionally but significantly influenced student responses. First off, we were asking students to say something each role would ask them and vice versa, however we asked all three questions at the same time. To some, this could come across as asking all three roles to be directly compared, prompting students to think more about something only that role would ask them, or something they would only ask that role–an

exclusively selected question rather than the first one that comes to mind. We also had a static order for the questions: LA, SC, then LTA. This may have caused responses like "Same as LA" or "Same as above". This meant the student was thinking comparatively, and that LAs, the first instructional role the survey discussed, was the standard the student was comparing the other roles to. In retrospect, we ideally would have asked about each instructional role in separate surveys at separate times to avoid any bias.

Finally, we struggled when coding questions that did not fit directly into the four or five categories we specified. These results made their way into the "miscellaneous" category, but they were interesting responses whose presence indicated a complexity in the data that we were unable to capture with our analysis. Ideally, we would have liked to conduct more analysis on these responses, but because each type of "miscellaneous" question could only be grouped with one or two others, we could not justify adding it as a code. Keeping our one month time limit and bigger picture conclusions in mind, we grouped them together and focused on the larger categories. Unfortunately, anything that ended up miscellaneous seemed to get ignored, but we wanted to keep the category in our results, rather than discarding those data points as erroneous because our lack of further analysis was due to time constraints, not a belief that these responses were insignificant.

References

Lorås, M. (n.d.). From teaching assistants to learning assistants – lessons learned from learning assistant training at Excited. Læring om læring. https://www.ntnu.no/ojs/index.php/lol/article/view/3555

Rubie-Davies, C. M., Blatchford, P., Webster, R., Koutsoubou, M., & Bassett, P. (2010).

Enhancing learning? A comparison of teacher and teaching assistant interactions with

pupils. *School Effectiveness and School Improvement*, *21*(4), 429–449.

https://doi.org/10.1080/09243453.2010.512800

Wang, J., Wang, Y., Wipfli, K., Thacker, B., & Hart, S. (2023). Investigating learning assistants'

use of questioning in online courses about introductory physics. *Physical Review.Physics*
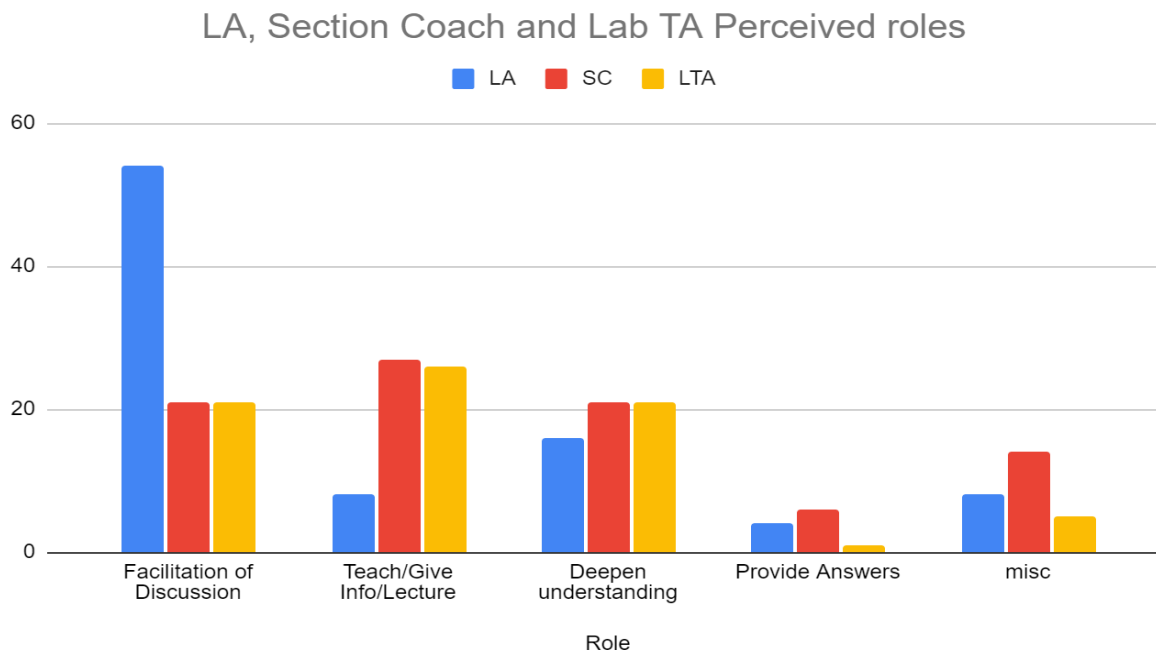
Education Research, 19(1) doi

https://doi.org/10.1103/PhysRevPhysEducRes.19.010113

Appendix

Figure 1: LA, Section Coach, and Lab TA Perceived Roles
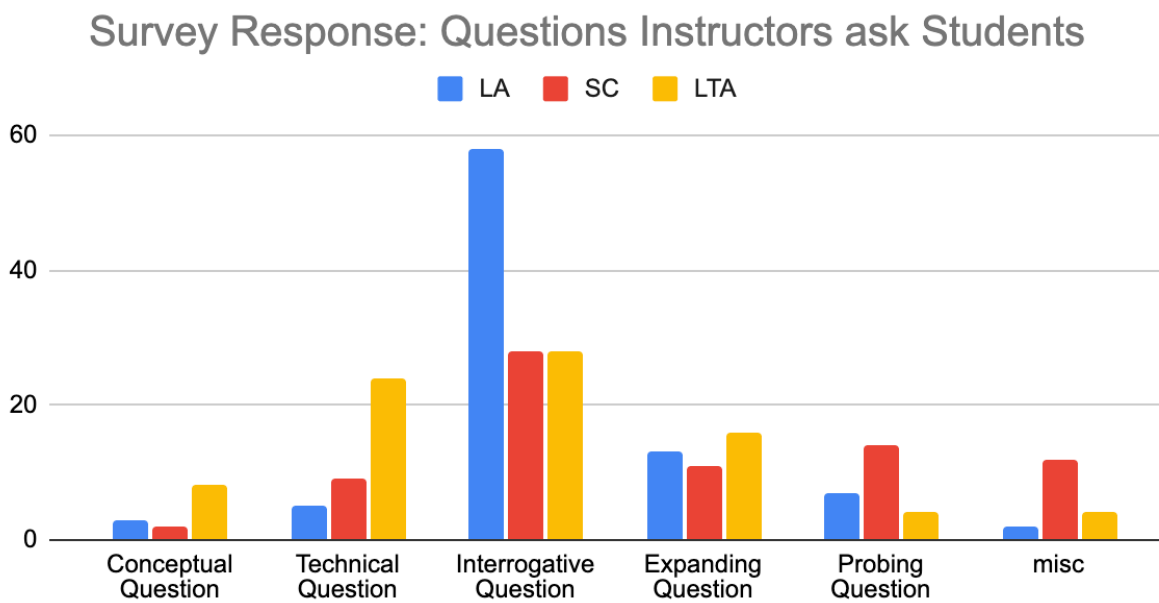
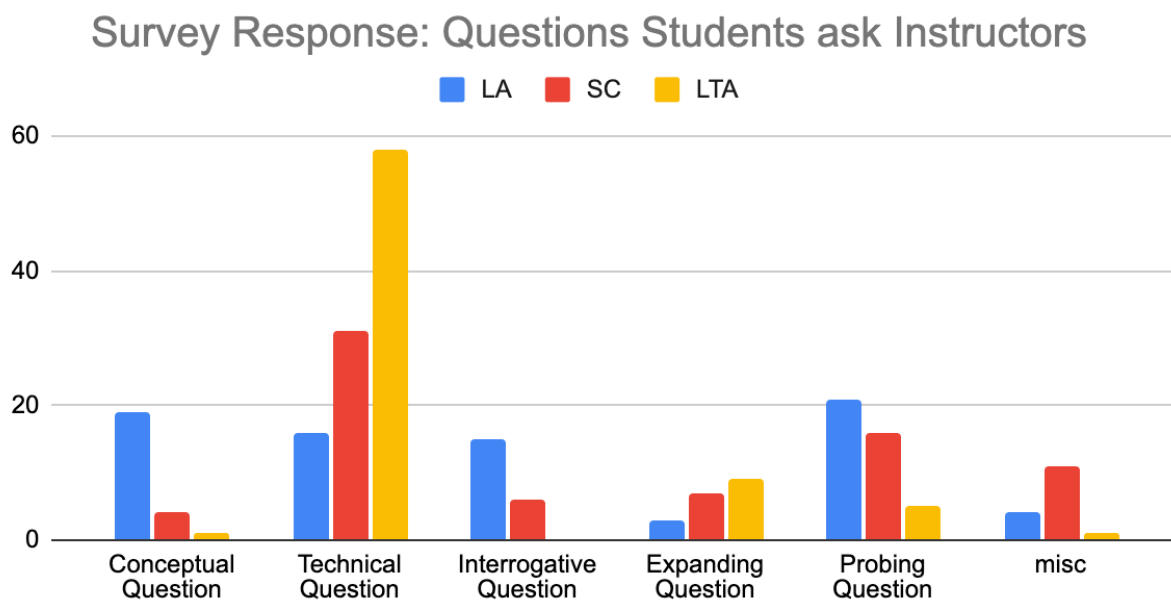Figure 2: Questions Students say LAs, Section COaches, and Lab TAs ask

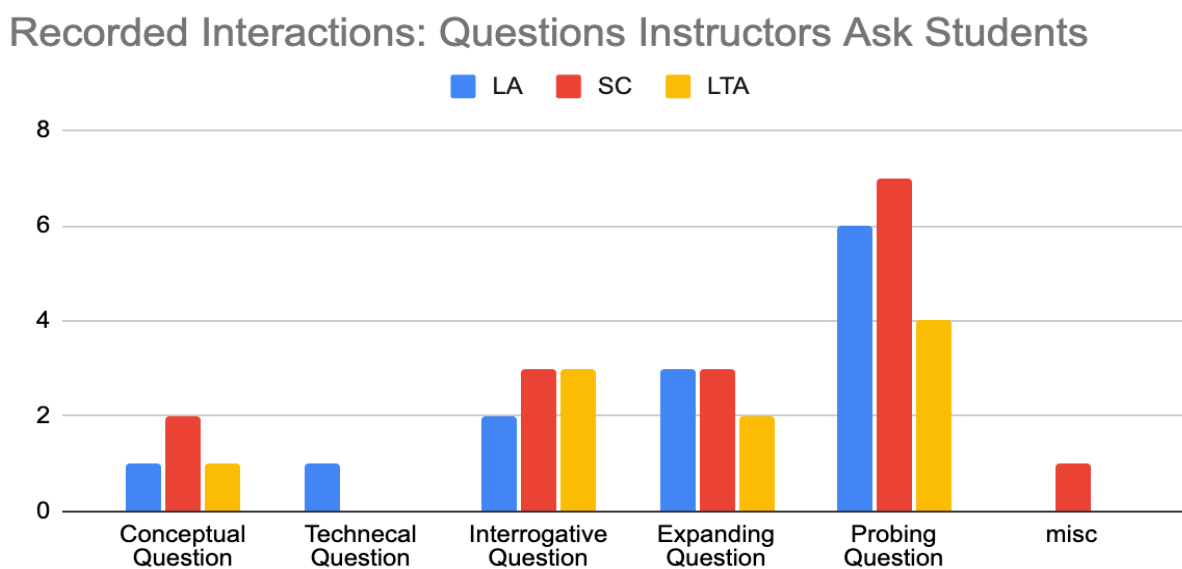Figure 3: Questions Students say they ask LAs, Section Coaches, and Lab TAs

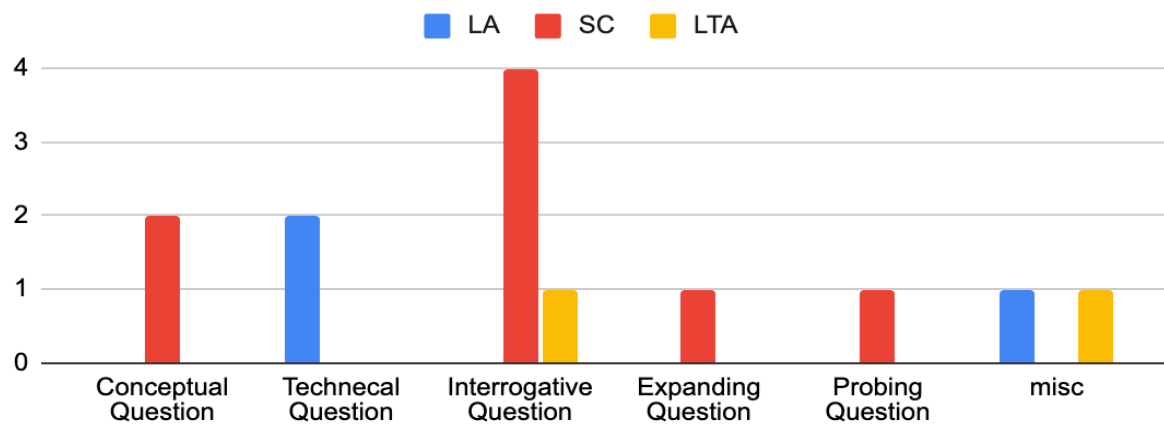Figure 4: Questions LAs, Section Coaches, and Lab TAs ask, Recorded Interaction

Figure 5: LA, Section Coach, and Lab TA Recorded Interactions with roles