Assessing Lab Assistant Attitude Shifts and Strength in Undergraduate Physics Labs

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ABSTRACT

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Following current physics education recommendations, the undergraduate physics labs at Brigham Young University are undergoing a shift in focus from conceptually-based to experimentally-based practices, which requires lab assistants to undergo a similar shift in attitude in order to perform at the higher level now asked of them. To assist with this change, we present a method involving new training techniques and attitude assessments based upon the three fundamental factors of attitudes—affect, behavior, and cognition—that identify attitude strength and weakness and pinpoint the underlying causes in a group of lab assistants. With the improved understanding of attitude causes from the data, faculty can target current training practices in real time to help solidify weak attitudes, as well as track attitude development over time. In our case study, we use the proposed method to successfully identify areas of attitude weakness and strength, their causes, and propose improvements for future targeted training meetings within a group of 20 lab assistants. We also propose a more comprehensive longitudinal future study to track attitude shifts over time.

Keywords: undergraduate physics labs, lab assistant trainings, attitude assessments

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1 Introduction

Lab instruction has historically been an integral part of physics education, traditionally designed to reinforce concepts from lecture courses and provide students the opportunity to see physics principles occur in real life [1]. Recently, however, physics education researchers and the American Association of Physics Teachers (AAPT) have recommended a shift away from traditional concept reinforcement labs, due to studies proving that these labs have little impact on student conceptual understanding [2-5]. Following these recommendations, Brigham Young University (BYU) physics lab courses have begun to undergo a shift in emphasis away from conceptual physics principles and towards experimental physics principles. While some aspects of conceptual understanding must necessarily remain a part of these lab courses, they are being redesigned to be discovery-based, focusing primarily on the principles of knowledge construction. Emphasis in these areas helps undergraduate students develop the skills and attitudes that will prepare them for undergraduate and graduate research opportunities and for future careers in STEM disciplines.

BYU's shift in lab focus heightens the requirements for lab assistant preparation, necessitating a shift in perception of their role as lab assistant. In concept-based labs, lab assistants prepare by understanding the physics concepts that students are learning and the procedures necessary to achieve results that would support those concepts. In discovery-based labs, lab assistants are required to act as instructors and mentors in the lab room, reinforcing and teaching the skills, attitudes, and abilities needed to conduct a successful scientific investigation. Thus, for this new emphasis to be fully planted in the lab room, lab assistants must shift from their previously conceived role of "concept explainer" in the traditional lab course to the role of "experimental consultor, mentor leader, and technical skill expert."

One challenge of this transition is that the attitudes and behaviors of these lab assistants are so ingrained and tied to their perceived role of "content explainer" that they tend to persist in old behaviors despite training efforts. For example, in the face of pressure, lab assistants tend towards helping students complete the required lab tasks as quickly and efficiently as possible, because they feel they can best help students by playing the "content explainer" role. They spend a large amount of lab time explaining the physics concepts behind experiments and what students "should see," rather than allowing students to learn directly from the experiments, to place authority on experimental data and process, and to participate in effective experimental practice. Recent attempts to counteract this behavior through clear explanations of expectations during assistant training meetings have only proven to be partially successful. When faced with social discomfort, high pressure situations, and discrepant events that cannot be easily explained, lab assistants still revert to the "content explainer" role with which they are more familiar. This demonstrates that lab assistant behavior has changed briefly to fit their desired role, but that their underlying attitudes towards their role as lab assistants have not [6].

Because these attitudes are so difficult to change, we have developed unique assessment methods based on the attitude model presented by Charles Stangor in *Principles of Social Psychology* [7] that will allow us to identify weak attitudes and target training methods in a brand-new way. Previously, physics educational researchers have identified weak attitudes and tracked attitude growth in students by comparing student experimental attitudes to those of experts in the field using assessments such as the Colorado Learning Attitudes about Science Survey (E-CLASS) [8]. While these assessment types are successful in identifying some weak experimental attitudes, they are unable to identify underlying causes of attitude weakness. Additionally, because they are geared towards students, these surveys do not measure attitude

types that are important to effective lab assistants, such as teaching and leadership attitudes. With the assessments we developed, we are able to pinpoint weakness in a wide variety of experimental, leadership, and technical lab attitudes, as well as identify the underlying causes of weakness, based on the attitude model. This allows faculty to make informed decisions and tailor training meetings cyclically throughout the semester to specifically address those causes of weakness for a unique group of individuals, without needing to wait until the end of the semester to identify attitude growth. Through this cyclic process, faculty can more closely maintain lab assistant group culture from semester to semester, despite the addition or dismissal of lab assistants. Additionally, with the information from these assessments and the improved trainings, lab assistants are able to confront their role confusion, develop and solidify new attitudes, and exhibit improved behaviors in the lab room with consistency, thereby improving the educational experience for both students and lab assistants.

2 Methods

Due to the scope of this case study, the methods will be discussed in four parts: psychological premise of the study, training meetings, development of assessment tools, and data strategies and limitations.

2.1 Psychological Premise

Because the basis of our study is founded upon lab assistant attitude structure, modification, and solidification, the following section will explain the basic psychological principles of attitudes, as modeled by Charles Stangor. Attitudes are described as a “relatively enduring evaluation of something, where the something is called an attitude object…[which] might be a person, product, or social group” [9]. These attitudes are formed based on three different types of psychological

data, which are commonly referred to as the ABCs: affect (emotion), behavior (actions), and cognition (moral reasoning) [7]. For example, a positive attitude towards recycling would rely on a positive emotional experience with regards to recycling, the individual performing the act of recycling, and the individual morally recognizing that recycling is good for the planet. When each of the three ABCs are aligned, as given in the example above, an attitude is solidified and considered "strong". However, if even one of the ABCs is misaligned—say, for example, that there is a negative emotional experience while recycling—that attitude is fragmented and considered "weak." Fragmented attitudes result most often in internal conflict and very temporary behaviors that are easily altered or changed according to the environment and situational pressures [10].

Because each ABC affects a different area of the brain, each of the ABCs requires a different strengthening technique [7, 11], as summarized in Figure 2.1.

Attitude Solidification Factors	
Affect	Positive rewarding, negative punishments, providing growth landmarks to display progress, positive or negative social pressures
Behavior	Behavior practice under pressure, action repetition, observational studies, self-assessments, goal setting, comfortability performing, diminished capability
Cognition	Social/behavioral observations, group discussions, self-assessments, cause-and-effect analysis, growth landmarks to display progress

Figure 2.1: Factors that can positively or negatively alter the ABCs of a particular attitude [7, 11]. In training meetings, these strategies can be used to target a certain ABC category to effectively solidify an attitude.

For example, if lab assistants exhibit positive affect and cognition toward asking open-ended questions but do not exhibit the behavior while in the lab room, we pinpoint the weak attitude of "asking open-ended questions." We then recognize that in this case both A and C of

ABC are solid and positive, so B is misaligned. We can then strengthen the attitude by providing more opportunity to discuss and practice asking open-ended questions during lab assistant training meetings and environments of low pressure. The repeated behavior then reinforces the emotional and cognitive links to the behavior, thereby solidifying the overall attitude of "asking open-ended questions." Then, in the higher pressures of the lab room, the lab assistant will feel more confident in their ability to ask open-ended questions, resulting in a positive increase of behavior.

For our case study, our lab assistant ABCs are analyzed to pinpoint weaknesses for a twofold purpose. First, we track attitude change over time to determine the overall success of lab assistant training methods throughout the semester, similar to the E-CLASS. Second, we identify ABCs that contribute to lab assistant role confusion, and cyclically refine current training methods to strengthen those specific ABCs.

2.2 Training Meetings

As mentioned previously, in order to aid the assistants in changing their attitudes, we needed to provide meaningful training activities that would appeal to their ABCs using the strategies mentioned in Figure 2.1. These meetings are intended to help the lab assistants confront and juxtapose their own attitudes, behaviors, and practices in the lab room with the attitudes of a leader, constructor of knowledge, and technical expert. By facilitating this type of confrontational attitude process and by practicing new behaviors in a controlled environment, lab assistants are able to experience all the ABCs to strengthen weaker attitudes.

Training meetings take place twice a week, but the lab assistants were only required to attend one of the two meetings. Of the total 25 lab assistants, no more than 15 assistants attended

a meeting at a time, and approximately 20 assistants would complete the required assessments. Lab assistants were paid their normal hourly wage to participate in the training meetings and other training activities, such as filling out post-training surveys, goal setting, or completing observations. The topics of each meeting depended directly upon lab assistant questions, trained observer notes, and current educational topics. Some topics include the role of a lab assistant in the lab, subconscious bias and microaggressions, teaching methods, asking questions, and roleplay. Each meeting employed at least one strategy from Figure 2.1, such as large group discussion, roleplay, cause-and-effect analysis, video trainings and discussion, or small group activities (Figure 2.2).

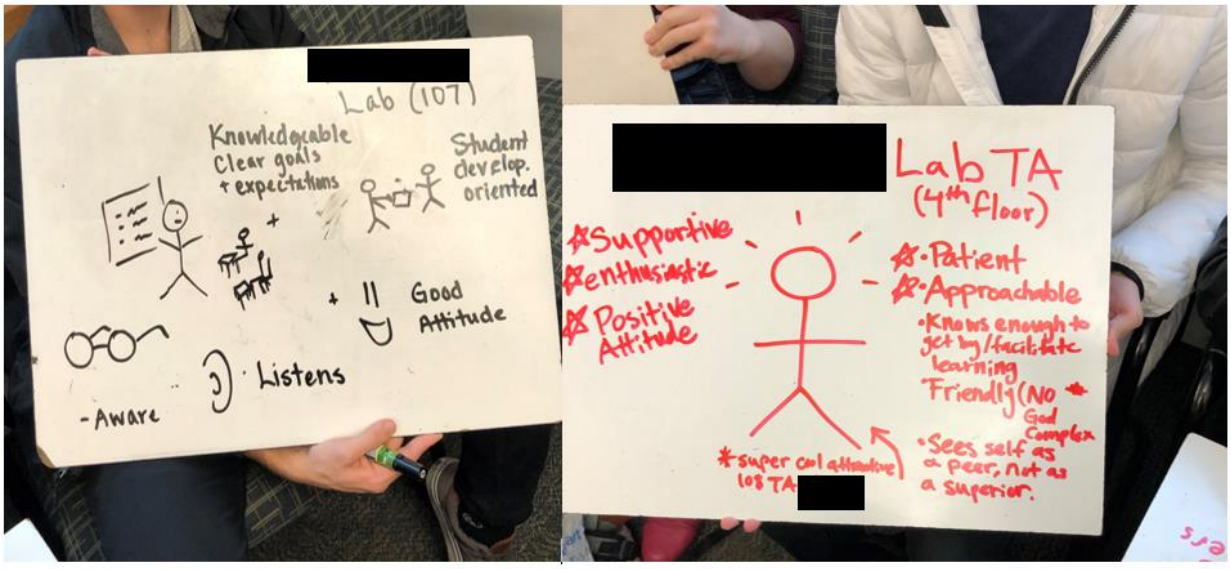

Figure 2.2: White board depictions completed by lab assistants during a small group discussion regarding the role of a lab assistant. Lab assistants were asked to depict what they believed the "ideal" lab assistant to be. Names have been blacked out from all images to preserve anonymity.

2.3 Development of Assessment Tools

In order to aid the assistants in changing their attitudes, we created an assessment method to determine the effectiveness of training meetings in aligning their ABCs, thereby signifying a solidified attitude. We also wanted some of these assessments to serve as part of the actual training process by providing observational opportunities, social interactions, self-evaluations, cognitive refinement, and growth landmarks. With these goals in mind, we developed three assessment types: self-assessments, post-training reflection surveys, and observational assessments.

2.3.1 Self-Assessments

The self-assessment is taken directly from the novel *Lift: The Fundamental State of Leadership* [12], which were provided as an exercise to the reader to self-assess current leadership attitudes. This self-assessment was intended to be completed twice throughout the semester: once near the beginning of the semester and once near the close of the semester. Lab assistants were asked to rate themselves as to how each of the statements applied to them. Following the assessment, they are asked to record three of the emotions they felt while completing the self-assessment and reflect on why those feelings emerged. These assessments not only provide lab assistants the opportunity to cognitively connect with, reflect upon, and set goals regarding their current attitudes, but also serve as a growth landmark to the lab assistants at the end of the semester. Responses to this particular assessment provides data for both the Affect and Cognition categories of ABC, as exemplified in figure 2.3

It is important to note, however, that this assessment only provides us with data for leadership attitudes, rather than for all attitude categories. The Affect and Cognition categories for other attitudes are derived from other assessments. However, in future semesters a self-

assessment we developed will be used that includes all of the required attitudes and correlates directly to the other assessments.

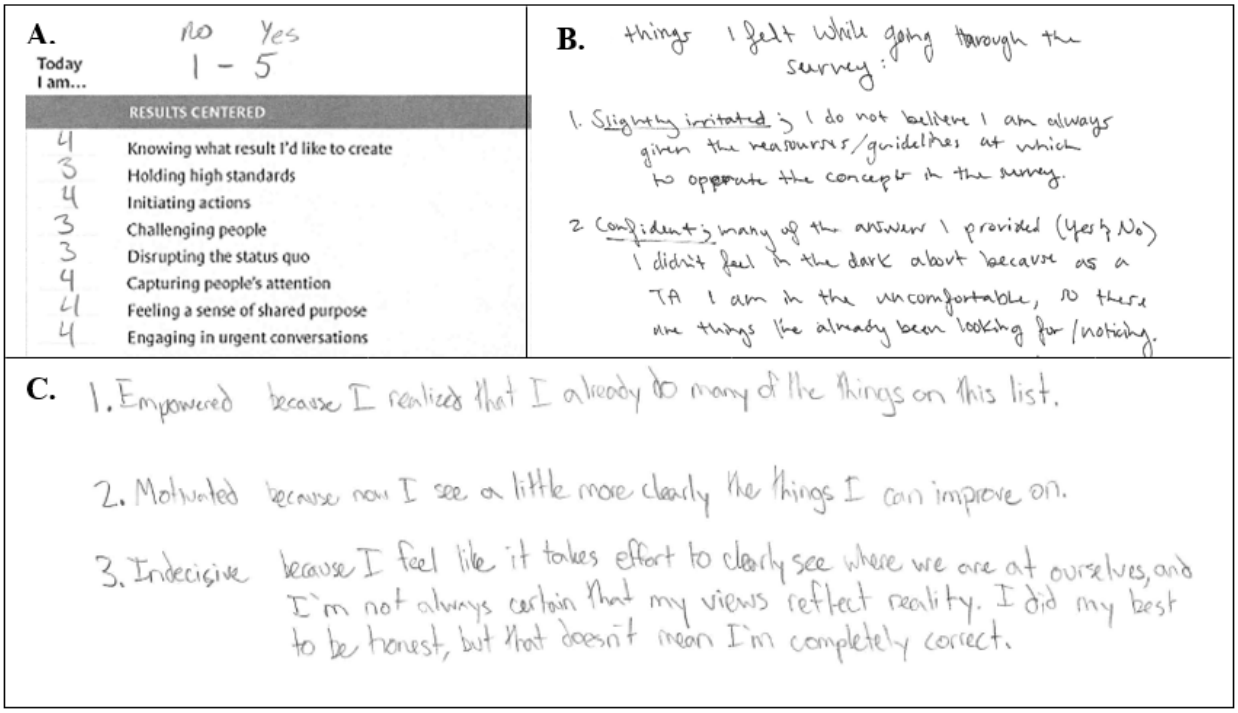

Figure 2.3: Anonymized lab assistant responses from the self-assessment. (A) depicts self-scoring on part of the questionnaire portion of the self-assessment, and (B) and (C) demonstrate the written responses with emotional and cognitive statements regarding the self-assessment.

2.3.2 Post-Training Reflection Survey

Additionally, we created a post-training reflection survey that lab assistants complete after each weekly group training meeting. This short survey includes questions that follow up on each individual lab assistant's goals set the previous week, set new goals for the coming week, and submit questions or concerns that were not addressed during the training meeting. Finally, they were again asked to reflect upon and record three of the emotions they felt during the training meetings, as well as what part of the training meeting evoked these emotions (figure 2.4). Similar to the self-assessment, these short surveys also provide lab assistants with the opportunity to

measure attitude growth, set goals, and connect emotionally to the training they receive, thereby solidifying the Affect and Cognition categories of the ABC.

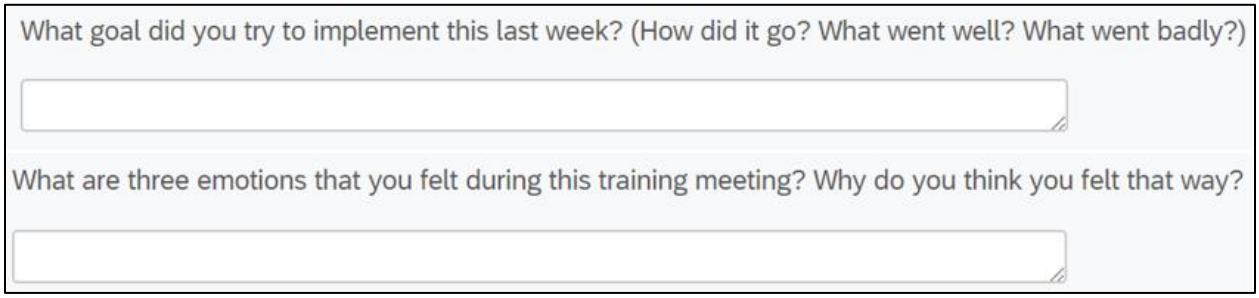

Figure 2.4: Two questions from the Post-Training Reflection Survey that each lab assistant is required to answer after every weekly training meeting. The entire survey is found in Appendix A.

2.3.3 Observational Assessments

We developed an observational assessment method called the Reformed Lab-Assistant Operation Protocol (RLOP), which was based on the design, methodology, and implementation of the widely utilized Reformed Teaching Operation Protocol (RTOP) for teachers. The RTOP allows a trained observer to assess an instructor's behavior, teaching methods, and student interactions in the classroom to determine the level of constructive teaching and traditional teaching occurring in the classroom. Using the same format and 4-point scoring system of the RTOP, we developed prompts that ask the observer to look for specific behaviors of leadership, knowledge construction, and technical expertise in the classroom over the course of an hour (Figure 2.5). The observer is also provided a comments section to discuss the situational context of the observation such as class size, nature of the lab activity, time constraints, and any other comments they may have regarding certain scoring sections of the survey (Figure 2.6). The observers were asked to not observe the first and last half hour of the lab class, simply to allow the observation to occur while the actual experiments are taking place, rather than during

equipment set-up and clean-up times that have little lab assistant interaction. After completing the survey, the observer is then prompted to again reflect upon and record three of the emotions the observer felt during specific parts of the observation and why they felt those emotions.

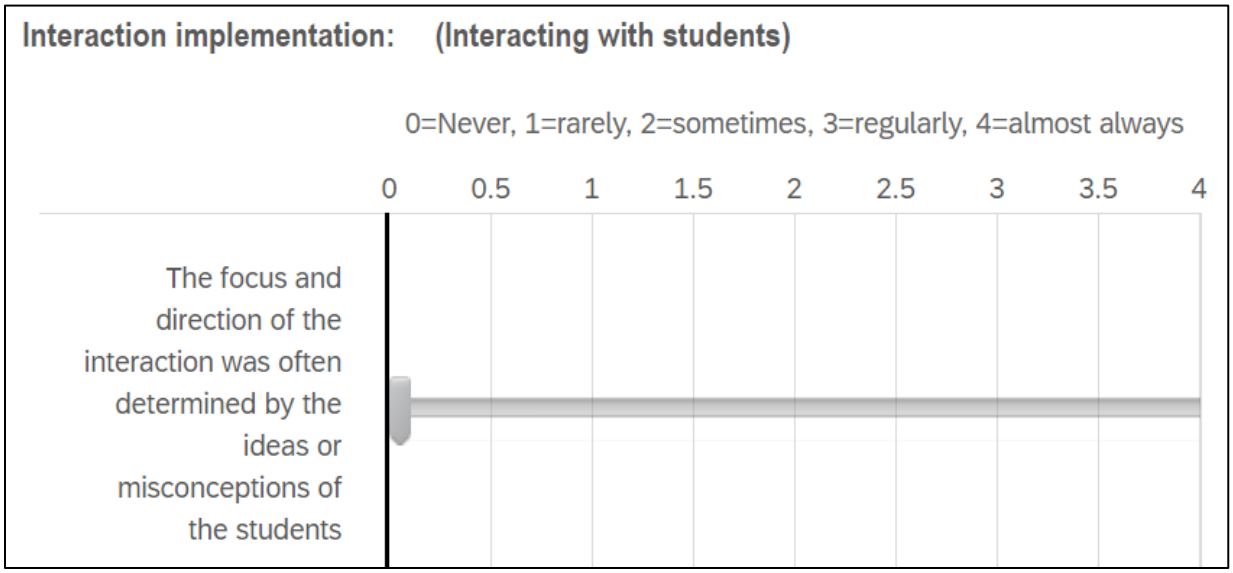

Figure 2.5: A sample question from the RLOP depicting the sliding 4-point scale for the observer to complete during the hour-long observational period. The entire survey is found in Appendix B.

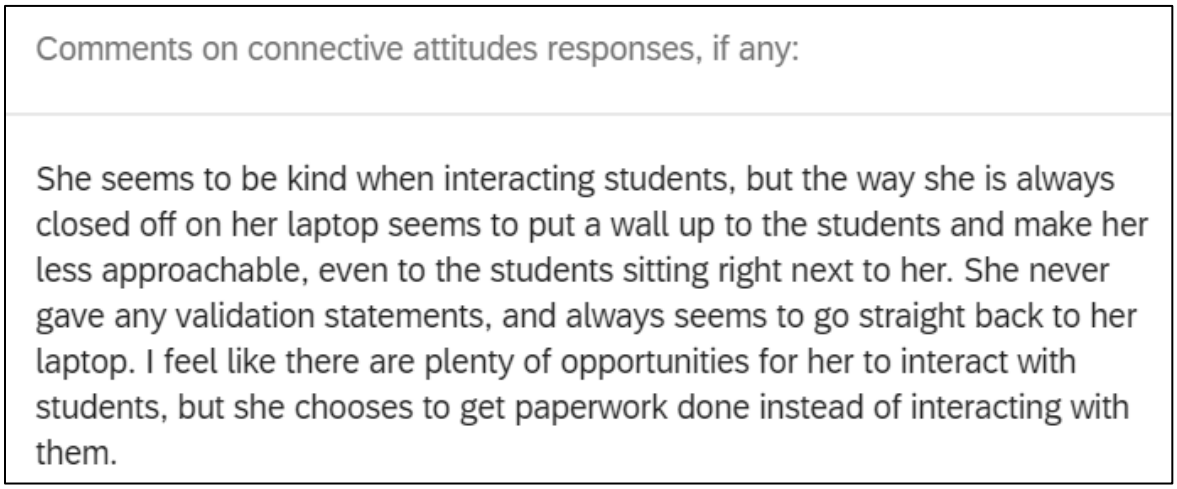

Figure 2.6: Sample comments from an observer regarding connective attitude responses to the RLOP scoring portion to support the scoring given by the observer.

In our case study, the RLOP is used in two ways. First, a trained observer from the research group would choose a handful of individuals to observe during the first few weeks of the semester to get a feel for common weaknesses among the lab assistants that should be addressed in the training meetings. These trained observers will continue to observe different lab assistants throughout the semester, providing accurate, unbiased behavioral data on general lab assistant strengths and weaknesses. These trained observers do not record their own emotions or cognition during the observation and write only what they observe the lab assistant doing during the hour.

Second, the RLOP is used as a social training exercise for lab assistants to observe each other's methods in the lab room, provide feedback to each other, and practice behaviors under a situation of pressure. Lab assistant observations are done in place of a regularly scheduled training meeting, and the assistants are allowed to choose a lab section to observe that fits into their personal schedule. No more than two lab assistants are allowed to observe each section at a time in order to minimize any disruption caused to the students in the lab. Together, both the trained RLOP observations and lab assistant observations provide meaningful information in multiple ABC categories.

2.4 Data Strategies and Limitations

Our case study relies on general trends and patterns that emerge from the written data taken from all of the assessments in the ABC categories, as well as the scored data from observational assessments. To account for bias, each type of data is handled in a different way that will allow us to identify key trends. This information then allows faculty to make well-informed decisions regarding training meetings throughout the semester.

2.4.1 Coded Data

In order to extract data from written responses, we created a codified system that uses key phrases to signify a type of ABC data. Any phrases that denote some type of emotion or begin with the words "I feel…" followed by an emotion are categorized as Affect data, third-party observations of actions are categorized as Behavior data, and morality statements, phrases using "I think" or imperative "should" statements are classified as cognitive data (Figure 2.7).

After each phrase is coded into one of the three ABC categories, they are then tagged as a positive or negative phrase. For example, the phrase "It made me uncomfortable because there were several condescending responses from the TAs" is classified as a negative phrase, due to the negative emotion being experienced, as well as a negative situation. Behavior observations are simply grouped as positive or negative behaviors. The omission of positive behaviors is also considered to be a negative behavior for the purposes of this study. These positive and negative statements are then grouped with the other statements regarding the same attitude in all of the ABC categories and analyzed to determine the alignment of an attitude (Figure 2.8). The agreement of all three ABC categories indicates a solidified attitude, whereas disagreement signifies a weakened, temporary attitude.

However, there are some limitations to this method of gathering and analyzing coded data. Because coded data relies on the voluntary offering of information, not all students will provide data in all categories. However, this case study focuses on a group of lab assistants as a whole rather than individuals, and the data collected will be analyzed according to a group attitude culture.

Example Phrases used to Codify Data:	
Affect	• **I felt** little stressed during this observation, just because there were so many questions and [the lab assistants] weren't getting answered very quickly • **I felt** accomplished—The students seemed to be getting things done more productively after talking with the TAs • **It made me uncomfortable** because there were several condescending responses from the TAs
Behavior	• [The lab assistant] never gave any validation statements, and always goes straight back to her laptop to grade after answering questions. • [The lab assistant] frequently debugs for the students rather than teaching them how to debug themselves. Very hands on. • Very few questions [by the lab assistant]. I don't remember hearing any. [The lab assistant] tends towards miniature-lectures. • [The lab assistant] listens carefully while the student speaks, asks for clarification, and waits for a few seconds before responding.
Cognition	• He spent most of this time with one student, which may have been necessary, but **I think** that this left other students without help for quite some time. • **Don't** just solve their problems for them. I noticed a lot of times especially when they were solving something mathematically that the TA would just walk them through the steps. • **I like how** [the lab assistant] guides the class more than telling them and uses comparisons to things they are already familiar with.

Figure 2.7: Examples of phrases from lab assistant assessments and how they are categorized as an ABC data type. Keywords and indicators are bolded. Note that some responses use the word "TAs" synonymously with lab assistant, and comments have been edited for clarity and anonymity.

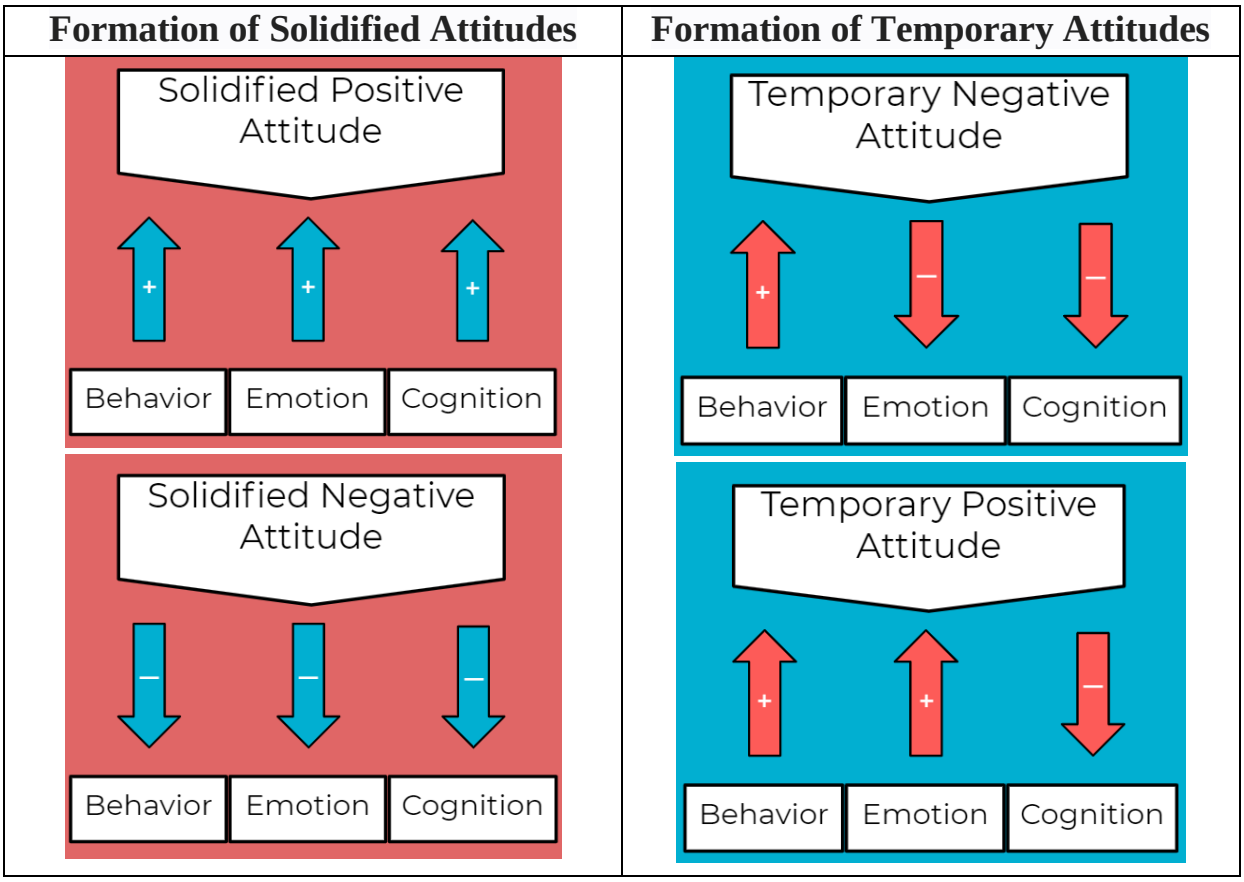

Figure 2.8: A graphic representation of solidified and temporary attitudes based on positive or negative Affect, Behavior, and Cognition (ABC) data. Note that only two examples of temporary attitude formations are included, but any attitude with misaligned ABC data is considered a temporary attitude.

2.4.2 Scored Data

For the purposes of this study, peer observation scores are casually compared to expert observer scores and coded data findings. This allows us to identify common trends during observational activities, correlations between scored and coded data, and possible areas of misunderstanding of survey prompts to better refine the surveys. An additional graphical representation overlapping both the expert and peer scores helps identify score inflation and relative attitude strength.

There are, however, significant limitations to this method as well. Because of the subjective scoring in peer RLOP observations by untrained observers, the numerical scores of

these assessments cannot be regarded as a completely accurate portrayal of behaviors. Additionally, only a handful of the lab assistants are observed by a trained observer during the case study due to the time burden imposed on the observer. Moreover, some behaviors may not be observed during observation activities, simply due to the hour-long time constraint. Because of these biases, these scores also do not completely indicate the exact behaviors exhibited by all lab assistants, but they are sufficient in identifying underlying trends.

3 Results and Analysis

Due to the beginning of the Covid-19 pandemic near the mid-point of the semester, traditional in-person lab courses and lab assistant training meetings were suspended, resulting in limited data collection. Only 10 expert observations, one round of 20 peer RLOP observations, one self-survey, and 4 training meeting reflections were performed prior to the shutdown. Because the analysis largely depended upon the longevity of the study, only initial trends are extracted from the data collected and discussed in this section, as well as suggestions for future trainings.

3.1 Coded Data Analysis

Due to limited data collection, it is possible that the indicated trends are not entirely reflective of the lab assistant group as a whole because the analysis relies on the voluntary inclusion of statements. Lack of coded statements in some attitude categories could have inhibited us from conclusively identifying an attitude as solidified. Due to this handicap, the coded analysis focuses solely on the attitudes of the lab assistants near the beginning of the semester where data is present in all categories. With these parameters in mind, our coded data analysis still results in the identification of a few significantly solidified and unsolidified attitudes, as summarized in figure 3.1.

Codified Data Results

0 = no statements given, +/- = 1-3 statements, ++/-- = 4-8 statements, +++/- - - = 9 or more statements

The type of mark indicates the type of statement: positive (+), negative (-)

	Interaction Implementation Attitudes	A	B	C	Attitude Status
1	The focus and direction of the interaction was often determined by the ideas and choices of the students	+	++	+++	Solidified, Positive
2	Instructor encourages and assists students in utilizing previous knowledge to design experiments and create models.	++	++	+	Solidified, Positive
3	Questions were used as an effective tool to engage the students, augment understanding of experimental concepts, and teach them to think critically.	+	-	++	Unsolidified, Positive
4	TA effectively avoids the classic "lecture" model in classroom discussions, but instead directs the discussion through questions and high proportion of student talk.	+	- -	-	Unsolidified. Negative

	Connective Attitudes	A	B	C	Attitude Status
5	TA attitudes reflected respect for the students and created a positive safe environment for the students to ask questions and learn	++	+	+	Solidified, Positive
6	TA's proactively seek out struggling groups and ask questions to promote understanding, rather than wait for the students to approach them.	0	+	+	Inconclusive
7	TA's give validation statements to students along with any correction needed	-	-	+	Unsolidified, Negative

	Technical Attitudes	A	B	C	Attitude Status
8	TA's effectively aid students in making their own predictions, estimation, and/or hypotheses and devise means for testing them	0	-	+	Inconclusive
9	TA's teach debugging skills and procedures in a way that empowers students to debug their projects without future aid. The TA DOES NOT do the debugging for them, except for major equipment malfunction.	-	- -	++	Unsolidified, Negative
10	Encouraged students to critically evaluate their experiment before and after performing it as well as seek alternative modes of investigation or of problem solving. This includes analyzing error.	0	-	+	Inconclusive
11	TA's work to promote technical literacy as well as understanding of what contexts certain techniques or equipment are appropriate for.	-	+	0	Inconclusive

* When faced with both positive and negative statements for a particular category and attitude, the statement type with the majority is reported, with the number of the minority statements subtracted from the majority count.

Figure 3.1: Codified data results for tested attitudes for a group of 20 lab assistants. Each statement is sorted to a specific attitude, attitude ABC indicator category, then classified as positive or negative. The difference in the number of positive and negative statements is reported for each attitude. If all three ABC categories for each attitude are either all positive or all negative, that attitude is considered solidified. Attitudes with both positive and negative ABC categories are considered unsolidified. Attitudes that are missing category data are automatically considered inconclusive.

As displayed in Figure 3.1, lab assistants displayed a solidified positive attitude towards letting the students determine the direction of the student-lab assistant interaction (attitude 1), using previous understanding and knowledge to help student understanding (attitude 2), and creating a respectful, positive, and safe environment (attitude 5). However, there appears to be attitude confusion regarding the use of questions to promote understanding (attitude 3), avoiding miniature lectures in the lab room (attitude 4), validating student efforts (attitude 7), and proper debugging procedures (attitude 9). The following paragraphs will discuss the unsolidified attitudes and possible causes.

During self-evaluations and training meetings, lab assistants indicated a lack of confidence in their ability to ask meaningful questions (attitude 3). After a training meeting targeted to this need, however, the goals set by the lab assistants were overly vague—over 7 of the 12 recorded goals set included some variation of "Ask better questions." Little to no behavioral change was observed or reported during expert observations or goal follow up. Alternatively, after participating in the peer observation activity, lab assistants indicated 6 statements of increased confidence in crafting meaningful questions and 8 more specific goals were recorded. This would indicate that the peer observations were more successful in improving the cognitive and affect aspects of this attitude than the training meetings, but only further behavioral data can confirm that the attitude has been conclusively solidified.

Additionally, lab assistants appear to have developed a negative unsolidified attitude towards a lecture teaching style (attitude 4). Despite the appearance of 3 emotional statements calling lectures "boring" or "too long," many lab assistants appeared to exhibit the behavior in the lab room during the peer evaluation observations and would justify the behavior in the comments section by stating that they "felt appropriate," "the students needed a base to work off

of," and "the students were a little lost." This indicates that the lab assistants do not yet have a solid understanding of exactly how avoiding a lecture teaching style can be more effective in student learning. This attitude was not the subject of a training meeting, but it was briefly mentioned during the meeting regarding questions. It is possible that the lab assistants would benefit from a specialized meeting on this topic that would incorporate role play and group discussion to target the behavioral and cognitive categories.

Lab assistants appear to cognitively understand the importance of giving validation to students (attitude 7), but the majority of lab assistants did not exhibit this behavior during observations. On two occasions, observers noted a few "snarky" validations that appeared to the be sarcastic and made them uncomfortable. Another statement by an observer indicated that giving validation sometimes feels like a waste of time. To combat this, a training meeting is again recommended to appeal to the emotional and behavioral portions of this attitude.

Lastly, attitudes towards the debugging process (attitude 9) appear to be extremely unsolidified in the behavioral and affect categories. 4 lab assistants reflected upon the importance of learning to debug for oneself, but there were 8 instances reported during the observations where the lab assistants debugged for the students and 1 instance where a lab assistant expressed frustration at the time required to teach the debugging process to a group of students. The incongruence between ABC categories here could be the result of lab assistants lacking confidence or giving in to logistic and time management worries. It could be beneficial to simulate debugging situations during a training to role play possible teaching methods that lab assistants could use. With more practice, confidence levels would increase and debugging time would decrease, appealing to both behavioral and emotional categories.

3.2 Scored Data Analysis

The comparison of expert observer scores and peer observer scores result in some interesting conclusions regarding point discrepancies and trend correlations to coded data. As shown in Figures 3.2 and 3.3, the expert average scores given generally ranged from 0.5 to 1.5 points lower than the scores the lab assistants gave each other. This could perhaps be due to the smaller data set of the expert observations, confusion regarding the meaning of the prompts, or the desire to give higher scores so they are not considered “mean” to the other lab assistants. In future observation activities, it could be beneficial to explain the meaning of the prompts and the scoring system in greater detail, perhaps through a practice observation roleplay during a training meeting. Doing so could potentially bridge the point gap between the expert and peer observation scores.

Despite this point discrepancy, relative score correlations between attitudes appear to be mostly consistent for both expert and peer observations. As seen in Figure 3.4, both trend lines for peer and expert average scores follow the same general pattern, though the expert average scores are shifted lower than the peer average scores. However, the behavior of attitudes 4 and 7 are noticeably different on each trendline, appearing quite high on the peer average scores graph and starkly lower on the expert observation scores graph. As mentioned previously in the coded data analysis, these two attitudes appear to be unsolidified and negative, but it is unclear why these two attitudes in particular do not correlate to each other. One possible explanation is that some lab assistants could be rationalizing certain behaviors, but there is simply not enough codified data to be conclusive.

Peer Observational Scores

	Interaction Implementation Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
1	The focus and direction of the interaction was often determined by the ideas or misconceptions of the students	1.50	4.00	3.42	0.71	0.51
2	Instructional strategies built upon prior knowledge and preconceptions as a baseline for further learning	1.50	4.00	3.13	0.77	0.60
3	Questions were used as an effective tool to engage the students, augment understanding of concepts, and teach them to think critically.	0.00	4.00	2.63	1.29	1.67
4	TA effectively avoids the classic "lecture" model in classroom discussions.	1.00	4.00	3.15	0.91	0.83
	Connective Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
5	TA attitudes reflected respect for the students and created a positive safe environment for the students to ask questions and learn	3.00	4.00	3.73	0.40	0.16
6	TA's proactively seek out struggling groups and ask questions to promote understanding, rather than wait for the students to approach them.	1.50	4.00	3.13	0.89	0.80
7	TA's give validation statements to students along with any careful correction needed	0.00	4.00	3.10	1.09	1.19
	Technical Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
8	TA's effectively aid students in making their own predictions, estimation, and/or hypotheses and devise means for testing them.	0.00	4.00	2.65	1.27	1.60
9	TA's teach debugging skills and procedures in a way that empowers students to debug their projects without future aid. The TA DOES NOT DEBUG FOR THE STUDENT, except for major equipment malfunction.	0.00	4.00	2.45	1.40	1.97
10	Encouraged students to seek and value alternative modes of investigation or of problem solving. This includes analyzing error.	0.00	4.00	2.45	1.35	1.82
11	TA's work to promote technical literacy as well as understanding of what contexts certain techniques or equipment are appropriate for.	0.50	4.00	2.98	0.99	0.99

Figure 3.2: Analysis of the scores from the peer observation activity. Maximum, minimum, and average scores are displayed for each of the questions, as well as the standard deviation and variance. 20 lab assistants were observed in the peer observation activity.

Expert Observational Scores

	Interaction Implementation Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
1	The focus and direction of the interaction was often determined by the ideas or misconceptions of the students	2.00	3.00	2.90	0.30	0.09
2	Instructional strategies built upon prior knowledge and preconceptions as a baseline for further learning	2.00	4.00	2.50	0.67	0.45
3	Questions were used as an effective tool to engage the students, augment understanding of concepts, and teach them to think critically.	0.00	3.00	1.80	0.98	0.96
4	TA effectively avoids the classic "lecture" model in classroom discussions.	0.00	3.00	1.30	1.00	1.01
	Connective Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
5	TA attitudes reflected respect for the students and created a positive safe environment for the students to ask questions and learn	1.00	4.00	2.90	0.83	0.69
6	TA's proactively seek out struggling groups and ask questions to promote understanding, rather than wait for the students to approach them.	1.00	4.00	2.50	0.92	0.85
7	TA's give validation statements to students along with any careful correction needed	0.00	3.00	1.50	1.02	1.05
	Technical Attitudes	Minimum Score	Maximum Score	Mean	Standard Deviation	Variance
8	TA's effectively aid students in making their own predictions, estimation, and/or hypotheses and devise means for testing them	0.00	2.00	1.00	0.63	0.40
9	TA's teach debugging skills and procedures in a way that empowers students to debug their projects without future aid. The TA DOES NOT DEBUG FOR THE STUDENT, except for major equipment malfunction.	0.00	2.00	0.90	0.70	0.49
10	Encouraged students to seek and value alternative modes of investigation or of problem solving. This includes analyzing error.	0.00	3.00	0.90	0.94	0.89
11	TA's work to promote technical literacy as well as understanding of what contexts certain techniques or equipment are appropriate for.	0.00	4.00	1.10	1.37	1.89

Figure 3.3: Analysis of the scores from the expert observation activity. Maximum, minimum, and average scores are displayed for each of the questions, as well as the standard deviation and variance. 10 lab assistants were observed during the expert observation activity.

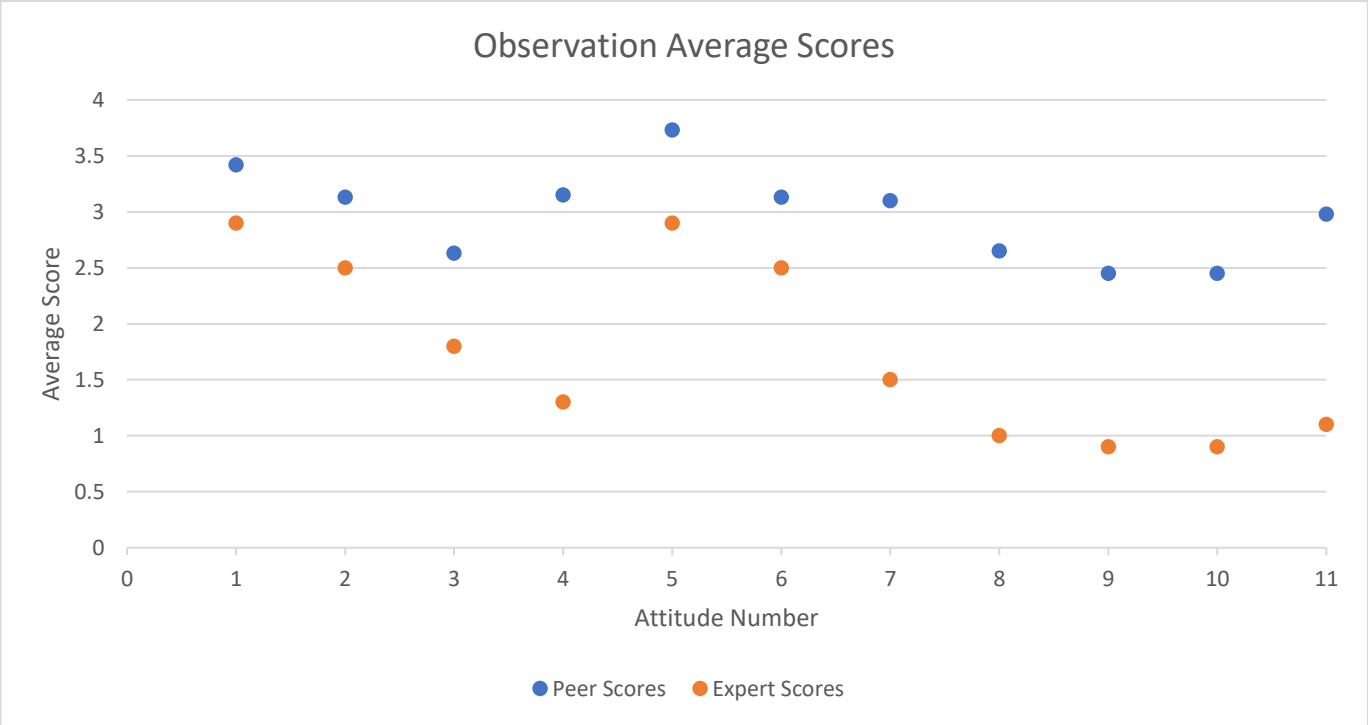

Figure 3.4: Average attitude scores plotted for both the expert and peer observations. Attitude numbers on the graphs correspond to the attitude numbers shown in figures 3.2 and 3.3. Both graphs depict similar trend shapes, but the peer average scores are shifted higher than the expert observation average scores. Attitudes 4 and 7 do not appear correlate as well as other attitudes between the two graphs.

4 Conclusions

Based on the preliminary data from the assessment tools we created, we identify attitudes 1, 2, and 5 to be solidified, and attitudes 3, 4, 7, and 9 to be unsolidified, as summarized in figure 3.1. This provides meaningful insight for faculty in designing new training topics and strategies by allowing the faculty to target specific ABC categories of each attitude. We also discovered that the scores given during observations by both peer and expert observers appeared to follow similar relative trends (Figure 3.4), except for attitudes 4 and 7. This phenomenon correlates with the conclusion that these attitudes are unsolidified, as determined by the coded data analysis. It is

unclear why the other unsolidified attitudes did not behave in a similar fashion, but it could be linked to behavioral rationalization by the lab assistants.

Unfortunately, due to the interruption in data collection caused by Covid-19, we were unable to measure the effectiveness of our training methods over the semester. To rectify this, we propose that a longer, uninterrupted, longitudinal study must be done to demonstrate the growth that lab assistants have over time. Due to the current climate of online teaching amid the pandemic, the training methods presented in this case study may require some adjustment to an online platform, but the psychological premise of this study remains key.

We must also note that these new methods were met with general acceptance and appreciation by our lab assistants. Many lab assistants commented that the self-surveys and observational surveys were helpful in identifying the expectations the faculty has of them as lab assistants. They also seemed to enjoy the concrete teaching and managing strategies they learned by observing other lab assistants. They did appear to tire of the sheer amount and frequency of surveys required for this study, however. Future studies should consider decreasing the survey burden to ensure quality data and minimize burnout.

With these adjustments, the proposed longitudinal study will allow us to continue to recursively improve our training meetings in real time throughout the semester by targeting specific attitude categories using the strategies mentioned in figure 2.1. Such improvements will solidify lab assistant attitudes, allowing them to perform at the higher level required of them in BYU's new experimentally-based labs.

Appendix A:

Post-Training Reflection Questions

Post-Training Reflection Instructions

We are interested in understanding the effect of different training activities on the development of teaching assistants. Throughout the semester you will be presented with information about teaching techniques and asked to answer some questions about it. Please be assured that your responses will be kept completely confidential, so please answer them thoroughly and honestly.

Q1 Your first and last name

_____

Q2 Which type of class do you TA for?

- 4th floor lab
- Tutorial lab

Q3 I attended the meeting this week.

- Yes
- No

Q4 What goal did you try to implement this last week? (How did it go? What went well? What went badly?)

_____
_____
_____
_____
_____

Q5 What are three emotions that you felt during this training meeting? Why do you think you felt that way?

_____

Q6 What specific aspect of this training do you intend to implement this week?

_____
_____
_____
_____
_____

Q7 Do you have any questions or other comments?

_____
_____
_____
_____
_____

Appendix B:

RLOP Questionnaire

Welcome to the observation activity!

This observation activity is part of your TA training, and the data we gather with it will serve two purposes:
1) TA learning and reflection on teaching methods
2) Our research study, for those of you who have already given us consent to use your information in the study. If you would like to opt out of the study for any reason, feel free to contact Dr. Nathan Powers.

This observation should take less than 1 hour: 45 minutes of observation and comments, and then 10-15 minutes of scoring and reflection. Please clock in while you complete this activity and manage your time wisely.

When you arrive at your observation section, take a moment to introduce yourself to the TA you are observing. Select a location in the room that will allow you to observe easily, but not disturb the students. If you are not sure of where to go, ask the TA you are observing where the best place for you would be.

Please enter the following information:
1) Observer's name
2) Name of the TA being observed
3) Course being observed (ex: 108)
4) Time of the observation (ex: 1:30-2:20 PM)

_____
_____
_____
_____

Please observe for 45 minutes. Write down detailed comments about the TA being observed while you observe.

The observer should include context about the section they are observing, such as class size, general atmosphere, and any meaningful events or interactions. Include any suggestions or ideas for improvement, as well as anything you feel the TA did well.

_____
_____
_____
_____

Observers, please make a note of three emotions that you felt while observing this TA interact with students. Why you feel that way?

_____
_____
_____
_____

After completing the observation, please indicate how often the following occurred during interactions between the observed TA and the students. The scale indicates that it was observed:

0= Never, 1= rarely, 2= some of the time, 3= Regularly, 4 = Almost always

Rating a 0 does not necessarily indicate that the TA did not do well in this area, it only means that you did not observe it in the time frame in which you were observing.

Please be sure to include detailed notes and examples from your observations in your comment section to serve as evidence for your given scores.

If you are confused as to what these statements mean, please visit this google doc, which will provide you with a few examples of what each statement might look like.

https://docs.google.com/document/d/1jK4gSPFGiysyRR6bYFKl3roq7ze5zDj1lAOcUHa5uwo/edit?usp=sharing

Interaction implementation: (Interacting with students)

	0=Never, 1=rarely, 2=sometimes, 3=regularly, 4=almost always 0 1 2 3 4
The focus and direction of the interaction was often determined by the ideas or misconceptions of the students	
Instructional strategies built upon prior knowledge and preconceptions as a baseline for further learning	
Questions were used as an effective tool to engage the students, augment understanding of concepts, and teach them to think critically.	
TA effectively avoids the classic "lecture" model in classroom discussions.	

Comments on the interaction implementation responses, if any:

_____
_____
_____
_____

Connective Attitudes: (Making connections)

0=Never, 1=rarely, 2=sometimes, 3=regularly, 4=almost always

	0 1 2 3 4
TA attitudes reflected respect for the students and created a positive safe environment for the students to ask questions and learn	
TA's proactively seek out struggling groups and ask questions to promote understanding, rather than wait for the students to approach them.	
TA's give validation statements to students along with any careful correction needed	
TA's encourage a growth mindset in themselves as well as in their students.	

Comments on connective attitudes responses, if any:

_____
_____
_____
_____

Procedural Behaviors: (Content/Skills taught)

0=Never, 1=rarely, 2=sometimes, 3=regularly, 4=almost always

	0 1 2 3 4
TA's effectively aid students in making their own predictions, estimation, and/or hypotheses and devise means for testing them.	
TA's teach debugging skills and procedures in a way that empowers students to debug their projects without future aid. (NOTE: TA DOES NOT DEBUG FOR THE STUDENT, except for major equipment malfunction.)	
Encouraged students to seek and value alternative modes of investigation or of problem solving. This includes analyzing error.	
TA's work to promote technical literacy as well as understanding of what contexts certain techniques or equipment are appropriate for.	

Comments on procedural behaviors scores, if any:

_____
_____
_____
_____
_____

What do you, the observer, feel you have learned from this observation activity? Was it a valuable experience?

_____
_____
_____
_____
_____

Thank you for your participation in this observation activity!

Bibliography

[1] Hofstein, A. (2017). The role of laboratory in science teaching and learning. Science Education, 357–368.

[2] C. Wieman and N. G. Holmes. (2015). Measuring the impact of an instructional laboratory on the learning of introductory physics. American Journal of Physics, 83, 972.

[3] AAPT Committee on Laboratories. (2015). AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum (AAPT, College Park, MD)

[4] Holmes, N. G., & Wieman, C. E. (2018). Introductory physics labs: We can do better. Physics Today, 71(1), 38–45.

[5] Wilcox, Bethany & Lewandowski, Heather. (2017). Developing skills versus reinforcing concepts in physics labs: Insight from a survey of students' beliefs about experimental physics. Physical Review Physics Education Research. 13 (1), 1-8.

[6] Glasman, L. R., & Albarracín, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. Psychological Bulletin, 132(5), 778–822.

[7] Stangor, C. (2015). Exploring Attitudes. In Principles of Social Psychology (1st ed.). Minneapolis, MN.

[8] Zwickl, B. M., Finkelstein, N., & Lewandowski, H. J. (2013). Development and validation of the Colorado learning attitudes about science survey for experimental physics. AIP Conference Proceedings, 1513(442).

[9] Albarracín, D., Johnson, B. T., & Zanna, M. P. (2005). The handbook of attitudes (pp. 223–271). Mahwah, NJ: Lawrence Erlbaum.

[10] Thompson, M. M., Zanna, M. P., & Griffin, D. W. (1995). Let's not be indifferent about (attitudinal) ambivalence. In Attitude strength: Antecedents and consequences (pp. 361–386). Hillsdale, NJ: Lawrence Erlbaum.

[11] Wood, W. (2000). Attitude change: Persuasion and social influence. Annual Review of Psychology, 539–570.

[12] Quinn, R. E., & Quinn, R. W. (2015). Lift: The Fundamental State of Leadership. Oakland, CA: Berrett-Koehler.