

Teaching Assistant-Student Interactions in a Modified SCALE-UP Classroom

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Abstract. In the spring term of 2010, Oregon State University (OSU) began using a SCALE-UP style classroom in the instruction of the introductory calculus-based physics series. Instruction in this classroom was conducted in weekly two-hour sessions facilitated by the primary professor and either two graduate teaching assistants (GTAs) or a graduate teaching assistant and an undergraduate learning assistant (LA). During the course of instruction, two of the eight tables in the room were audio and video recorded. We examine the practices of the GTAs in interacting with the students through both qualitative and quantitative analyses of these recordings. Quantitatively, significant differences are seen between the most experienced GTA and the rest. A major difference in confidence is also observed in the qualitative analysis of this GTA compared to a less experienced GTA.

INTRODUCTION AND BACKGROUND

In Spring 2010, the Oregon State University physics department instituted a SCALE-UP (Student-Centered Active Learning Environment for Undergraduate Programs) style studio classroom in the introductory, calculus-based physics series. SCALE-UP style classrooms have been instituted at a number of schools across the country, often with significant increase in learning gains[1]. However, the efficacy of SCALE-UP is limited by the skill of the instructional team, which frequently includes not just the leading professor but also several teaching assistants (TAs). Often these TAs serve as a student's primary contact, acting as a middleman between the students and the professor. In such a role, the TAs frequently have far more direct interaction time with the students.

Currently, the professional development program at OSU is regarded as not helpful in preparing GTAs for teaching[2], so a better professional development program is desired. While there is some research that has been done in the area of TA professional development[3-6] and TA beliefs[7, 8], most of these studies only look at TAs in relatively traditional settings, namely a laboratory style arrangement of students working on tutorials rather than the different environment of SCALE-UP. The SCALE-UP program does have some materials for TA training, however, the OSU implementation differs from the original, and thus may require modifications to such training. Therefore, in order to improve the TAs at OSU, a new professional development program must be designed. To do so, we begin by performing a preliminary analysis on the practices and beliefs of the current TAs at OSU so that the TAs' strengths and weaknesses may be determined.

The SCALE-UP Classroom

Key features of our implementation of the SCALE-UP design are eight circular tables which each seat up to nine students. These nine students are then subdivided into three groups of three students each. Each table contains three laptops, one per group, and has one Hitachi StarBoard serving the dual roles of projection and smart board space for group work. Students also made frequent use of large, portable white boards where the entire group could work simultaneously. Students were then given a variety of tasks to complete, some more conceptual, some more mathematically rigorous. The GTAs and LA circulated among the tables, generally at a ratio of approximately one GTA or LA per four tables, or roughly 36 students. The professor would also aid in helping students, however, the professor also had to attend to details such as timing, technology issues, capturing students' work, and management of the whole classroom, rather than concentrating solely on aiding the students.

The GTAs

Four GTAs are considered in this preliminary study. The first is "James." James taught in the SCALE-UP room for only one term, however, he is the most experienced GTA, having taught for three years prior to working in the SCALE-UP room. Further, he is recognized by instructors as an excellent TA that is both effective and liked by the students. Second is "Jessica", a GTA with one year of experience, but studying physics education research. "Greg" likewise focuses on physics education research, but is newer to the field. He has TAed for two years, however. "Rachel" is a first year graduate stu-

dent, having no prior TA experience, though she had been a student in a SCALE-UP classroom (not at OSU) for her undergraduate introductory physics series. However, Rachel had an atypical preparation, as she had not originally planned on attending graduate school for physics and thus lacked some of the common upper division undergraduate courses of the other graduate students.

METHODOLOGY

To study what both the students and TAs were doing in the classroom, three video cameras were installed and the GTAs were informed of the recording. These recorded both audio and visual data for all three SCALE-UP sections each week of the term for four consecutive terms, covering the standard introductory series from Spring 2010 to Winter 2011, and then beginning again in Spring 2011. These were aimed at two different tables on each half of the room. After the end of the term, each video was then scanned in high speed to tag them for interactions between a TA and a student, with the start and end times of these interactions being recorded. Interactions that were not actual dialogue, such as a TA answering the question "Which activity are we on?" and then moving on, were ignored as they do not actually show details of the GTAs' behaviour. The interactions were then grouped by academic term for bulk quantitative analysis. The analysis consisted of calculating a few basic statistical measures, primarily the mean duration of interaction, as well as the variance in the duration of interaction.

A preliminary discourse analysis was also conducted on videos, selected for being representative for a certain GTA. This was done to gain greater understanding of exactly how and why the behaviour of GTAs differed, since this cannot be determined directly from quantitative methods. Two of the GTAs were chosen for detailed analysis for this paper. James and Rachel were selected as one is the most experienced GTA while the other is the least experienced GTA, and thus any significant differences between the two are likely to be very clear. The selected interactions between those GTAs and the students were then analyzed. Due to significant background audio noise in the videos, this discourse analysis focused primarily on the gestures and posture of the GTAs in relation to the students.

A gesture is defined as, "the spontaneous hand movements of individual speakers – movements that are directly tied to speech and are created at the moment of speaking"[9]. In Scherr's paper, she discusses that gestures can indicate a speaker's perception of the novelty of an idea. Ideas in which the speaker and listener share some sort of common ground experience are usually accompanied by gestures that are less precise or complex than when the speaker and listener do not share some

common basis. The gesture analysis of the videos focused primarily on this aspect because many of the other functions of gestures, such as facilitating idea construction or indicating "pre-articulate" ideas should not apply to GTAs teaching introductory physics, as, hopefully, their ideas about Newtonian mechanics, energy, and introductory electromagnetism are both articulate and already constructed.

FINDINGS

Statistical Analysis

Several interesting results presented themselves upon examining the data shown in Table 1 on the next page. First, the GTA with both the lowest interaction time and the smallest variance in interaction time is James, the most experienced GTA. Conversely, the GTA with the longest time and greatest variance is Rachel, the least experienced GTA. The margin of difference is particularly shocking, as the standard deviation of James' interactions is over three times as small as Rachel's when she taught the same materials a year later. Further, even among the other experienced GTAs during any term, the next closest any other TA comes is still twice that of James. James' average duration is also significantly shorter than the other GTAs. While James was noted as being the most experienced, such significant differences indicate that he may be doing something fundamentally different than the other GTAs. Further study on exactly what James is doing when interacting with the students, and whether it is effective, is warranted.

In Greg's average times, we see a generally rising pattern as the course materials go from relatively easy in the spring to the typically most difficult in the winter, and then drop again once the curriculum starts over in the spring. While it makes sense that more difficult materials require more time, no other GTA shows this pattern, so if the term affects the average duration, it is likely that other factors have a much greater influence. It is also interesting to note that while Greg's average duration of interaction decreased from Winter 2011 to Spring 2011, Rachel's actually increases significantly. This may be an interesting change to study in more detail, as it would be expected that interaction durations would decrease when the curriculum moves from the typically difficult term of electricity and magnetism in the winter to the easier subjects of kinematics, Newtonian mechanics, and energy in the fall. Overall, the data suggests that more experienced GTAs are more consistent and efficient in the interactions. Coding these interactions may provide a method for analyzing the interactions in greater detail to see if this general trend is accurate.

TABLE 1. Average Duration and Standard Deviation (in Minutes) of TA-Student Interactions by TA and Term

TA	Spring 2010	Fall 2010	Winter 2011	Spring 2011
James	1.28 ± 0.62	X	X	X
Jessica	1.78 ± 1.21	1.58 ± 1.43	X	X
Greg	1.67 ± 1.27	2.14 ± 1.54	2.56 ± 1.32	1.94 ± 1.39
Rachel	X	2.47 ± 2.45	1.69 ± 1.27	2.84 ± 2.01

Discourse Analysis

During the discourse analysis, it was noticed that James frequently made very small, controlled gestures when interacting with students. According to Scherr, this indicates that when conversing with students, James believes that he and the students have some kind of shared experience to build from. This is further supported by the fact that James taught only the first part of the series concerning basic kinematics, Newton's Laws, and energy and momentum, subjects which most students should have every day familiarity with, and thus a common basis. James' posture was also very consistent. James often approached students calmly, standing upright with his hands in his pockets.

Further, James' responses to student question were often quick, and commonly involve simply reflecting the students' question back to them. When he did explain things in a longer monologue, his voice kept an even pitch very close to one he used in conversation with peers. His exchanges with students were often very fluid, with few stops or breaks in his speech, as shown in the following exchange in which James aids students in constructing an energy bar chart for the situation of a ball released from rest near the surface of the earth.

S1: We're confused.

J: Ok.

S1: With the, uh, earth drawing a bar thing, the earth, would it be negative? Or would it be initially negative?

J: Alright, so, initially the ball isn't moving. Is the earth moving?

S1: Yeah, yes.

S1, S2: No.

J: Relative to the earth.

S1: Oh, no.

S3: So they're both at zero.

S1: And then the earth still is not moving, so the earth is at zero and the ball is

J: Alright, let me ask you this, is there a net force?

S1: What?

J: Is there a force?

S1: Yes.

S2: Gravity.

S1: Gravity.

J: And then, internal or external?

S2: External.

S3: Internal. (James points at S3 and nods)

S1: Does it matter?

J: Well, what, ah, what is your system?

S1: Ball and the earth

S2: The earth, ah, and the earth's gravitational pull.

(Pause)

J: It's the earth and the ball.

S1: Yeah.

S2: So there is no external force on it then, now that we've (bracketing gesture with hands), ok.

While James does give a good deal of information to the students, he is reinforcing to the students course goals, such as identifying the system. Further, after the interaction, the students seem to indicate a greater understanding of the situation, with student 2 joking that, "My world is falling down around me," before correcting himself, "No, actually the Earth is falling towards me." In total, James' gestures, physicality, and vocal patterns indicate a confident person that believes he and the students share a common ground in discussing physics. His self confidence was confirmed in an interview in which he stated that he felt he was doing many of the things an ideal TA should do[2].

Rachel, on the other hand, shows different habits. Rachel's gestures tend to be fairly large, and precise. Often, her gestures were more similar in character to those made by students than to those made by James. This indicates, according to Scherr, that Rachel thinks that the material she is explaining is new to either the students or herself, and thus they do not have a common basis for discussion.

Physically, Rachel is often seen playing with clothing, such as her scarf or the ties on a hoodie, as she approaches and interacts with students. This is often complemented by an increased pitch to her voice, as well as an increased speaking tempo. Her explanations are often broken as well, as seen in the following partial exchange, wherein Rachel is aiding students in solving a problem involving thin film interference in a soap bubble.

R: Hi, how are you guys doing?

S1: Pretty bad.

(Students laughing)

S2: We don't really know, like, where to begin....
 R: Where to begin.
 S2: ...at what ...
 S3: I'm sorry, are we supposed to use, like, the color, at the bottom, to, like, for something? I can't tell what color it is.
 R: Yes, you'll need that actually, but, yes, so think about what's actually happening. So...
 S3: You just
 R: You've got that bubble (claps hands together), right, it's (short pause)
 S2: The bubble.
 R: The bubble, ok and on either side you have air, so think about the layers, the air, film, and the air again and how the light hitting those layers (short pause)
 R: So start by drawing these layers.
 S3: Like this? You can't do that.
 S1: Is that the...
 R: Wait, if you're gonna draw...
 S1: The angle of ... whatever.
 S2: That thing?
 R: No, sort of, but...

In this interaction, Rachel shows repeated hesitations, with her sentences usually trailing off rather than actually ending. Further, dialogue such as, "Yes, you'll need that actually, but, yes,..." shows her reconsidering her answer, even while in the process of giving it.

This sort of interaction, when combined with Rachel's other qualities, indicates that she may not have much confidence as a TA yet. Much of her physicality suggests nervousness, and her dialogue indicates uncertainty. This view is reinforced by entries written by Rachel in a reflective journal[2]. One such entry reads, "Students were asking me questions and I was listening to their answers, and their answers started to confuse me. I felt like I wasn't able to give any good advice because I started doubting my own knowledge. Even though I have reviewed the materials beforehand, I felt overwhelmed."

SUMMARY

In examining both the quantitative and the qualitative data, several patterns emerge. First is that James is a very different TA than the others. His interactions are short, and with relatively little variation in duration. His gestures indicate that he believes that he and the students have a common ground in discussing the physics of a situation. Further, he appears confident, and stated that he has a great deal of self confidence.

Rachel, conversely, tends toward long interactions with significant variation in the duration. She often appears nervous and lacking in confidence, and admits to such in a reflective journaling exercise. She also appears to believe that she and the students do not share a com-

mon basis for discussing physics, though whether this is due to her own lack of confidence or a belief in that the students do not have a common basis is a matter for further investigation. Confidence and experience are the two major differences between James and Rachel, and given the significant differences between the two GTAs, any future GTA professional development design will have to take these factors into account by giving the GTAs a method to practice TAing. Such practice would increase their experience, while positive feedback from practice would improve TAs confidence in their abilities.

Future work will focus on looking more closely at not only how the GTAs act, but also how the students respond to GTAs. Specifically, recordings will be reviewed and behaviours will be coded. Student responses to these behaviours can then be coded, and from this behaviours can be classified according to how much they aid the students in gaining understanding of the materials as demonstrated by the students' post interaction discourse. Particular focus will be placed on James, as his very different behaviour is likely to have very different results. This can then serve as a basis for the development of a GTA professional development program to better prepare GTAs for teaching in the SCALE-UP environment.

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