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## Introduction

Many researchers have explored the impact of graphing technologies in mathematics classrooms (see Heid & Blume, 2008). The implementation of such instruments often raises questions related to new complexities concerning the teacher's role in supporting rich student learning (Guin, Ruthven, & Trouche, 2005). In recent work, researchers have examined ways that teachers use whole-class discussions to guide and shape students' mathematical activity with these types of instruments (e.g. Drijvers, 2011). This present study builds on and extends related research by specifically targeting teacher actions used to support students' graphing calculator use in small group settings.

## Research Question

What types of instrumental orchestrations does a teacher implement with students who are working within small groups?

### Emergent Questions: As the Analysis Progressed

- What does the teacher do during the interactions?
- Who operates the graphing calculator during the interactions?
- Who initiates the interactions?
- Who does the thinking during the interactions?
- Who does the talking during the interaction?
- Who assumes the mathematical authority?

## Method

Following a case study design adapting Drijvers' (2011) *instrumental orchestrations* as an analytical framework, I observed and video-recorded a single high school teacher's instruction focusing on quadratic functions over the course of four days. Coding of the video data revealed patterns in the ways that the teacher supported student activity with graphing calculators. Post-lesson interviews were used to triangulate the observed orchestrations.

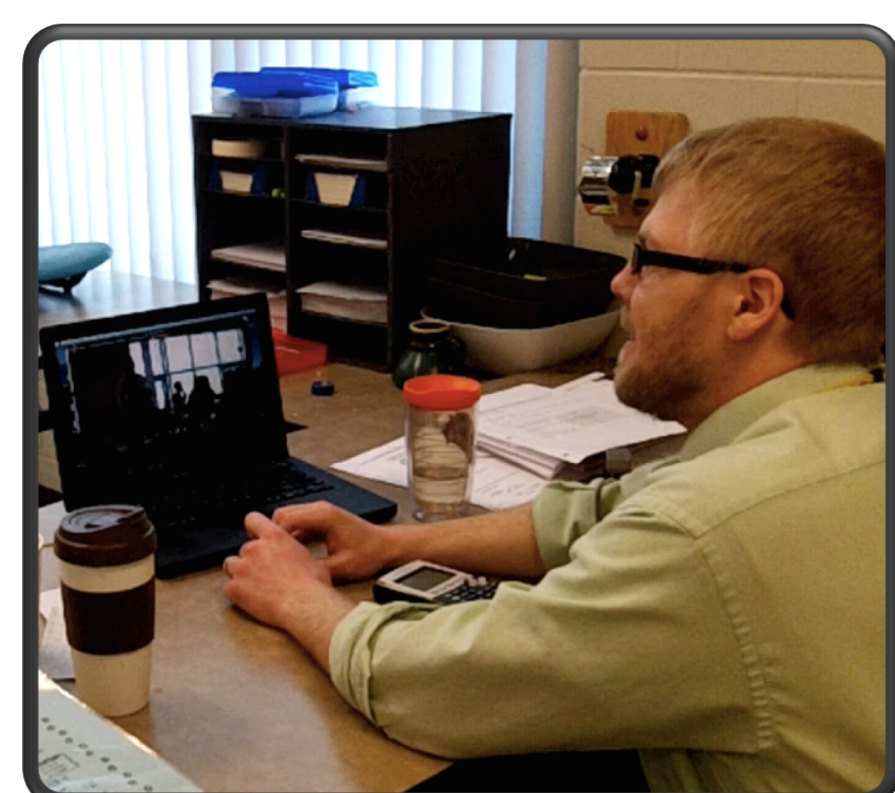


Figure 1. Teacher Interview

# ONE TEACHER'S INSTRUMENTAL ORCHESTRATIONS OF STUDENTS' SMALL-GROUP WORK WITH GRAPHING CALCULATORS

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## Initial Results

The teacher heavily favored the use of two types of orchestrations, the *Work-and-Walk-by* and the *Technical-Demo* (Drijvers, 2011). While implementing the *Work-and-Walk-by* orchestration type, the teacher primarily verified that students were on task and making progress towards solving the assigned problems (Figure 6). The *Technical-Demo* orchestration, however, was implemented in multiple ways, which led to the delineation of three subtypes of orchestrations: one where the teacher computes without showing students the keystrokes used on the graphing calculator (Figure 7); one where the teacher shows the keystrokes used (Figure 8); and one where the teacher performs some of the graphing calculator operations and pauses to prompt for student input and thinking (Figure 9).

## Response to the Research Question

The teacher primarily implemented teacher-centered orchestrations, influenced by student unfamiliarity with some aspects of the graphing calculators.



Figure 2. Classroom Configuration

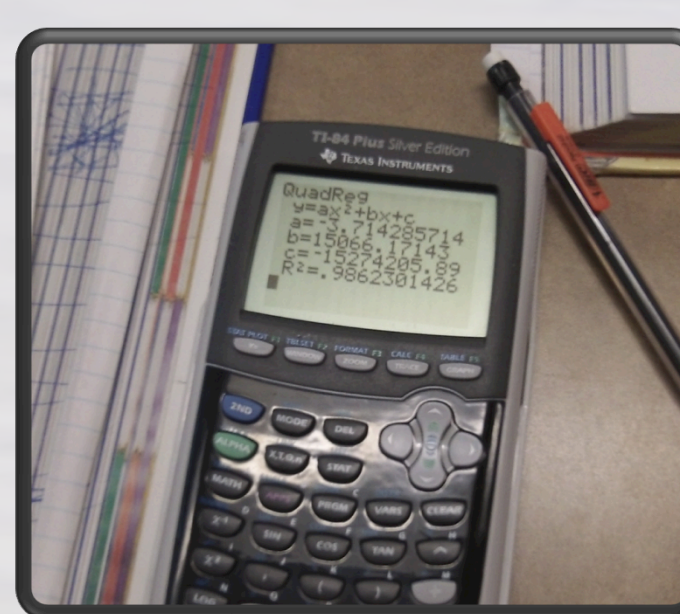


Figure 3. Quadratic Regression

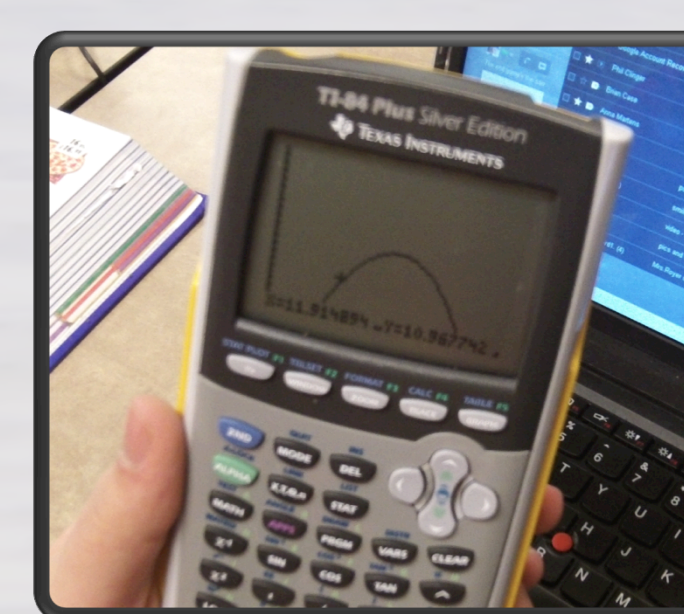


Figure 4. Graph

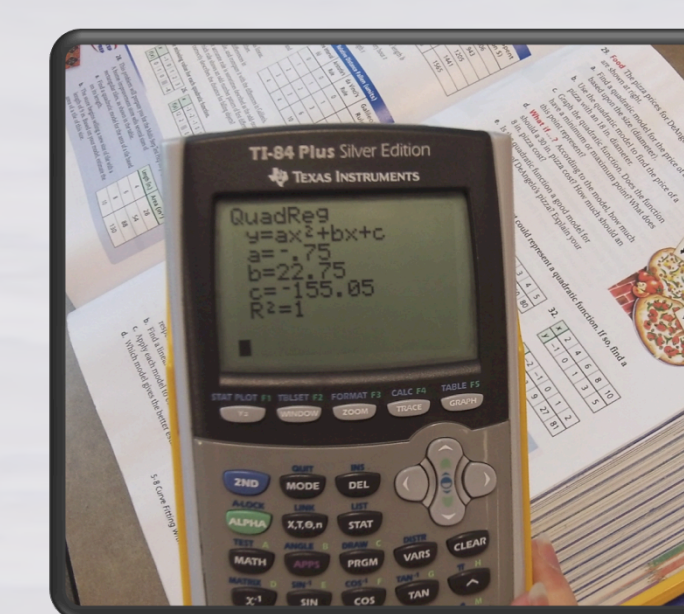


Figure 5. Second Regression



Figure 6. *Work-and-Walk-by*

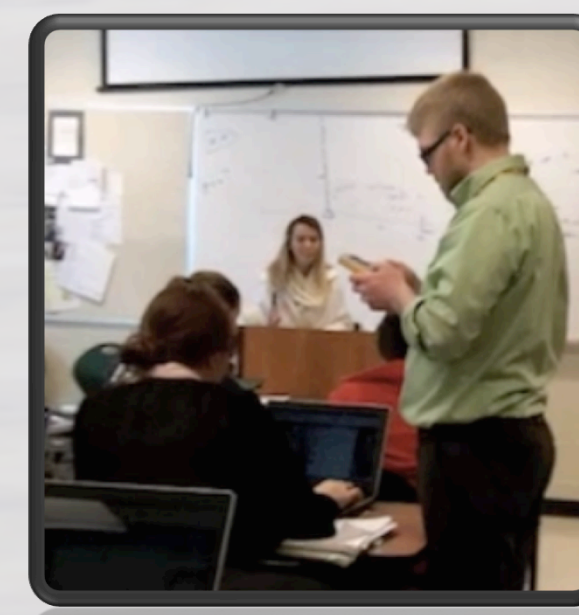


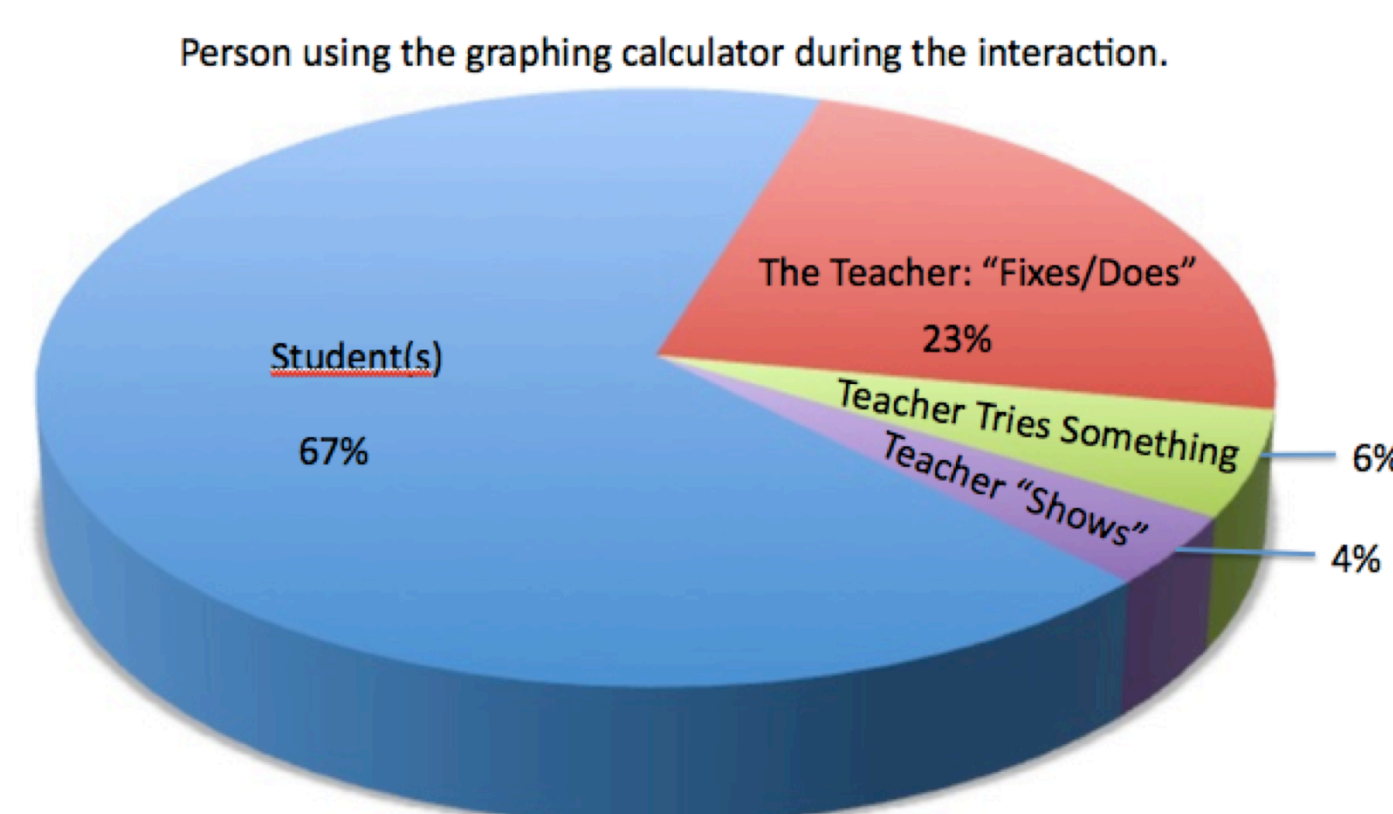
Figure 7. *Teacher-Do*



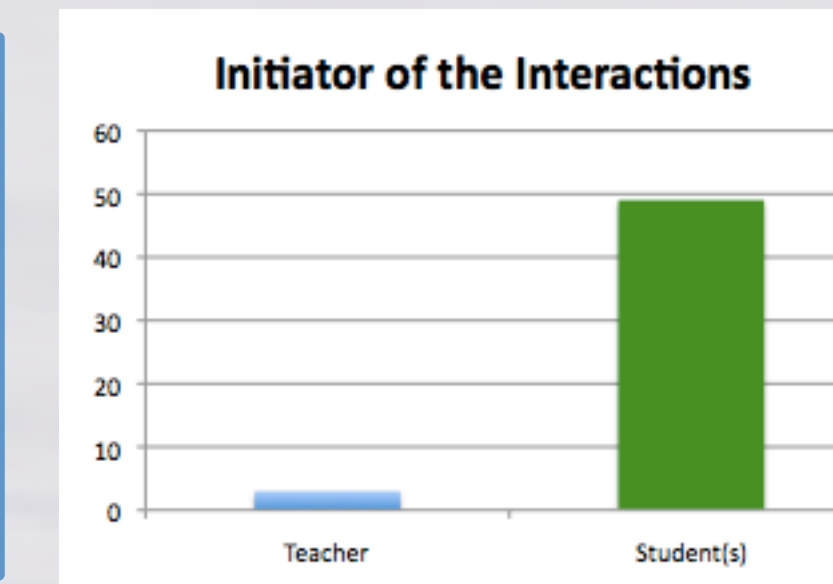
Figure 8. *Teacher-Show*



Figure 9. *Teacher-Do-and-Ask*



Despite the fact that the interactions were most often initiated by the students and the students often maintained physical control of the graphing calculators, the observed dialogue between the teacher and the students suggests that the teacher was responsible for the mathematical and technical authority during the orchestrations.



### Classroom Observation: Day 4 (39:54 to 40:07)

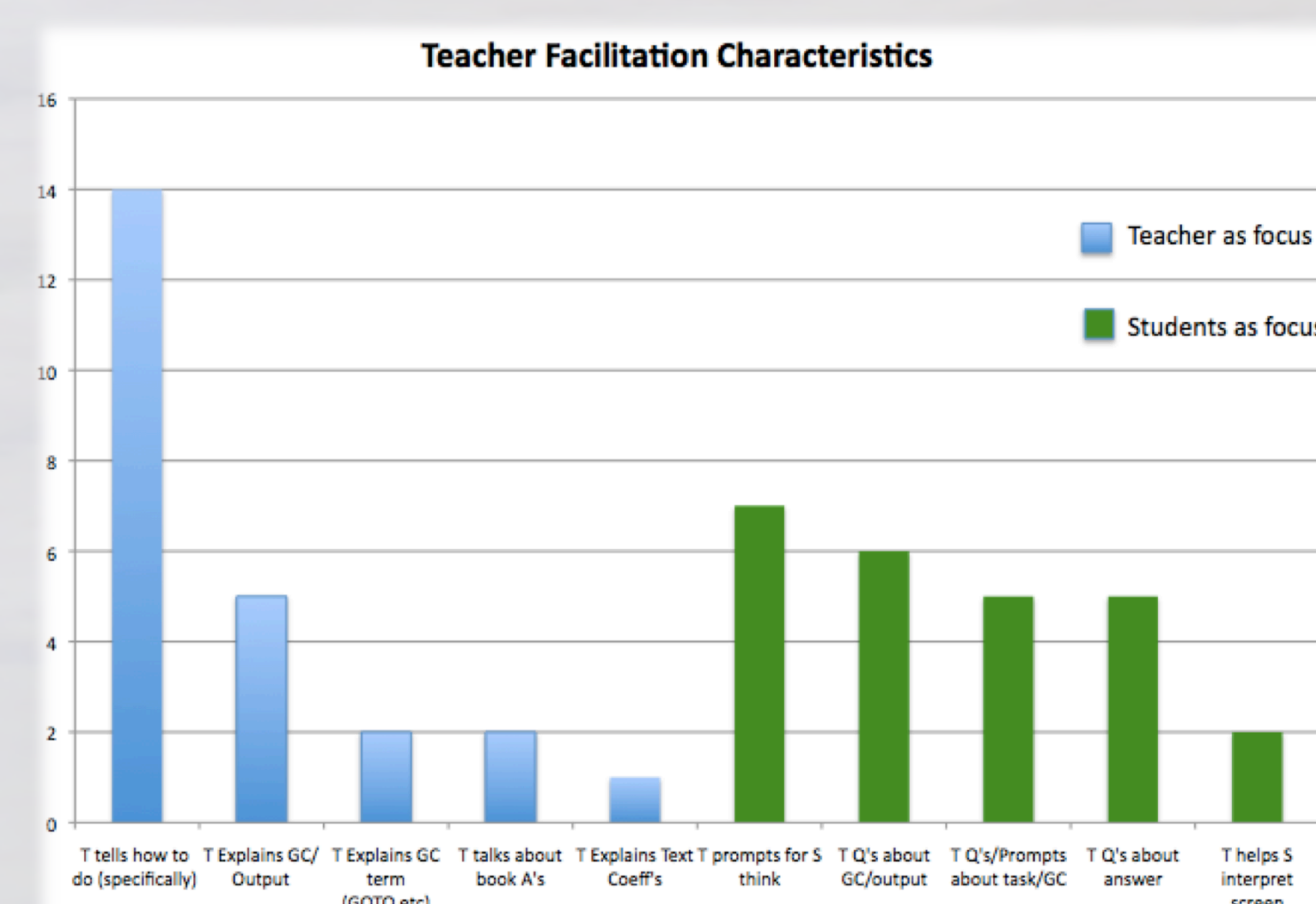
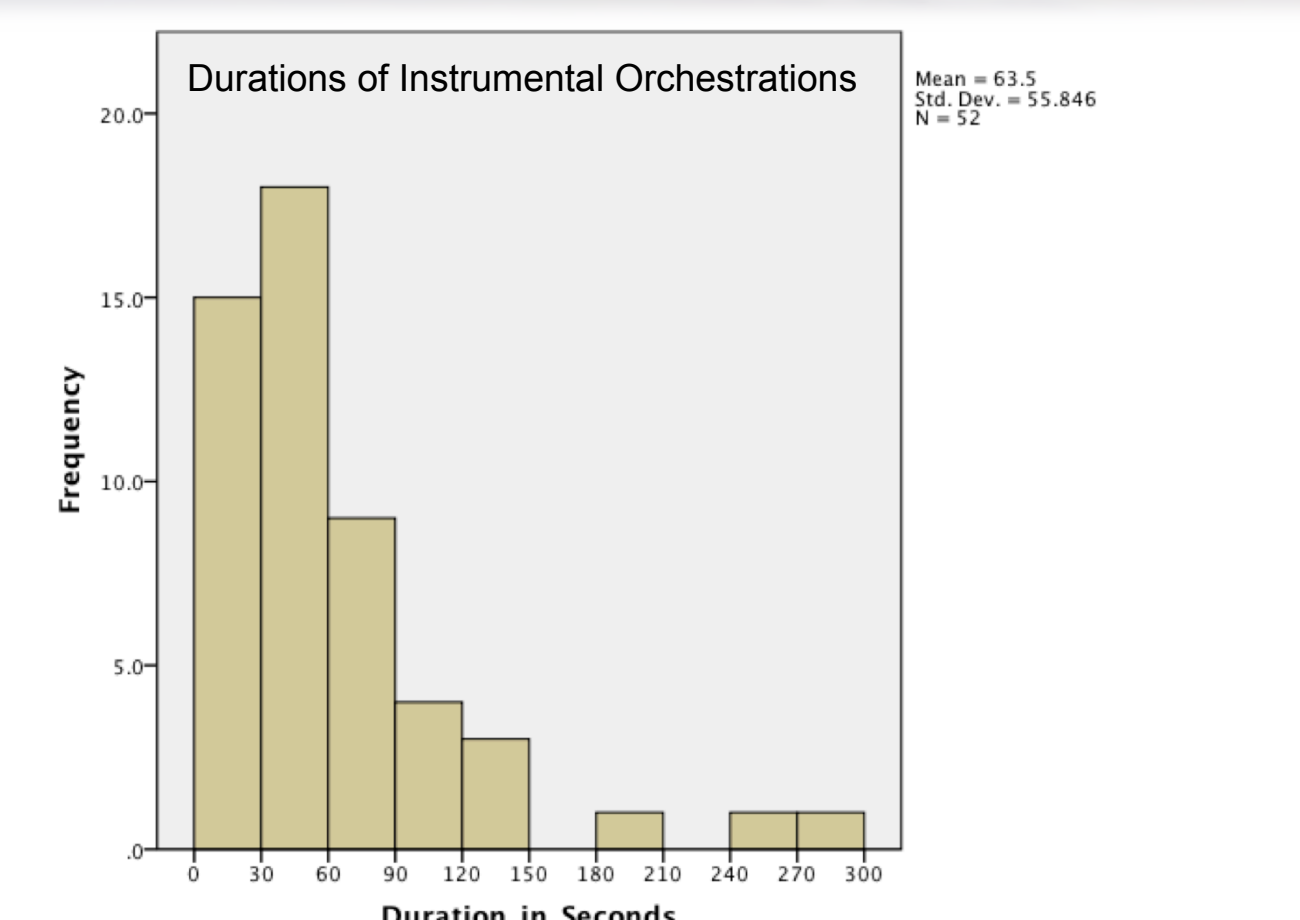
T: Yeah?  
S: Okay, we got the answer.  
T: [verifies the student's output on the calculator] Awesome!  
S: Do we have to do the quadratic... [quadratic regression]  
T: Yes.  
S: Okay.

### Classroom Observation: Day 3 (14:39 to 15:02)

T: 'Kay,  
S: I just got it to here [indicating progress with the graphing calculator].  
T: Yep, so we're looking for the average dimension of the frame – so, we've got two dimensions. Just average them together.  
S: Alright.  
T: And then the cost goes in the other one [referring to a data list].  
S: Alright.  
T: So the 'L2' is going to be the cost list right down there, and then the 'L1' – just average the two numbers together each and put the averages in there.  
S: Okay.

### Classroom Observation: Day 4 (44:02 to 44:26)

S: How do I get those zeros off from there [pointing at extra data values entered into a list], 'cause it's messing up what the thing is -  
T: [while pressing the 'delete' button so that the student can see the screen change] Delete, delete, delete, delete, delete, [pause] delete. You wanna push the last delete?  
S: Yeah, sure.  
T: [in a supportive tone] 'Atta-girl!



## References

- Drijvers, P. (2011). From 'work-and-walk-by' to 'sherpa-at-work'. *Mathematics Teaching*, 222, 22-26.
- Drijvers, P., Doorman, M., Boon, P., Reed, H., & Gravemeijer, K. (2010). The teacher and the tool: instrumental orchestrations in the technology-rich mathematics classroom. *Educational Studies in Mathematics*, 75, 213-234.
- Guin, D., Ruthven, K., & Trouche, L. (Eds.). (2005). *The Didactical challenge of symbolic calculators: Turning a computational device into a mathematical instrument*. New York, NY: Springer.
- Heid, M. K., & Blume, G. W. (Eds.). (2008). *Research on technology and the teaching and learning of mathematics: Volume 1: Research syntheses*. Charlotte, NC: Information Age Publishing, Inc.



Figure 10. Student Collaborations