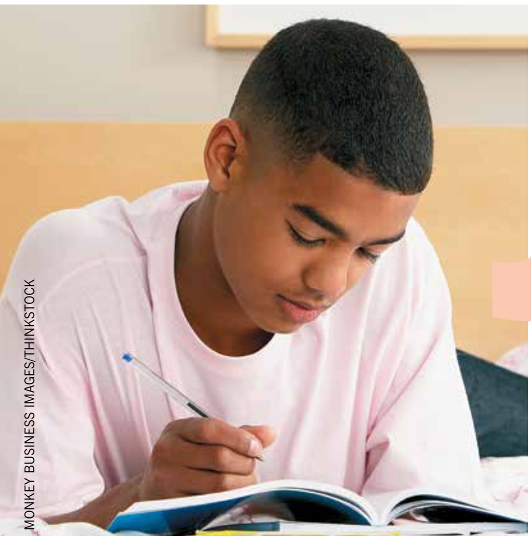
"Can You Tell Me More?" Student Journaling and Reasoning

Jan A. Yow



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Journaling in mathematics has been found to be a valuable tool both for students and for teachers. Students benefit from journaling because it advances their mathematical understanding and ability to communicate in mathematics; teachers benefit by reading students' written thoughts, a resource that is not readily available, and by engaging with students through written feedback (Albert and Antos 2000). I sought to use journaling to further develop reasoning and sense making (CCSSI 2010; NCTM 2010, 2014) through teacher and student responses to each other in journals. In so doing, I also wanted to promote students' critiques of one another's thinking and written mathematical discourse.

A CLASSROOM EXAMPLE

This work occurred in a mathematics class that focused on algebra. Each week, one class period was dedicated to "lab time," which included inquiry-based lessons that applied to core course topics such as slope, data collection and analysis, and linear equations. These activities generated multiple opportunities for journal writing, resulting in 450 journal entries over a semester.

The Calculator Based Ranger 2 (CBR 2™) motion sensor activity, in particular, was well suited for journaling. As others have done in the past, students used the CBR 2 to investigate slope (Doerr, Rieff, and Tabor 1999). The motion sensor collects data in real time as students move in front of it. The data are then displayed on a graphing calculator. Distance from the motion sensor is plotted on the y-axis against elapsed-time on the x-axis. The class began with a demonstration of the use of the motion sensor at the front of the room. Students were then invited to break into smaller groups to experiment on their own by "playing around," such as moving in front of the main sensor to become familiar with how it gathered data as they moved. First, I asked students to create lines of positive or negative slope with their movement. Then, the students had to match their movements to graphs generated by the CBR 2.

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Before students were asked to physically match the graph, they wrote descriptions in their journals about what they *predicted* a student would have to do to match the graph. This allowed them time to make sense of what needed to happen after having worked just minutes before with the CBR 2. After completing their written descriptions, students exchanged papers with a partner and offered written feedback to one another. As shown in **figure 1**, initial entries were purely descriptive, but then progressed toward more conceptual aspects of mathematics. The work in example response 1 showed that the student recognized the importance of the y-intercept when offering descriptions ("start 2 feet away") and hinted at slope when indicating movement (at an "average speed"). Once students offered their written descriptions to classmates, they realized the need to be specific with mathematical language so as to communicate necessary actions. **Figure 2** illustrates a student's understanding that he needed to include the y-intercepts and slope (2 seconds/1 foot) in subsequent entries.

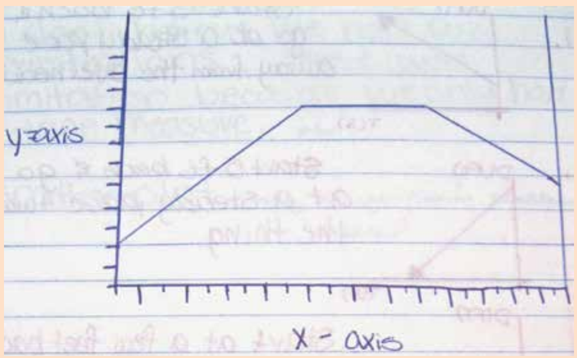
After sharing their predictions and feedback, students were prompted to compare one another's predictions, as shown in **figure 3**. Although some student responses were vague (e.g., "My strategy was different"), other responses included more detail. The student entry in **figure 3** recognized the benefit of using the y-intercept as a specific beginning point. The third journal entry (see **fig. 4**) was the last journal prompt of the day, and I used it to close the activity. At the end of each class, I collected all journals to read and write responses to each student. This practice allowed me to see how students were making sense of the concept and how they were responding to one another, thus providing me with another layer of

A small group used a CBR 2.

Fig. 1 Initial entries started out being purely descriptive, but then moved into deeper conceptual territory.

Journal prompt 1: What do you predict a student will have to do to match this graph?

Student response 1



Student 1 entry: Start 2 feet away from the thingy and move at an average speed away towards the wall. Take a breather and then slowly walk towards the thingy again.

Classmate 1 response: Good job, has good detail. I think that would work just great! Don't change anything.

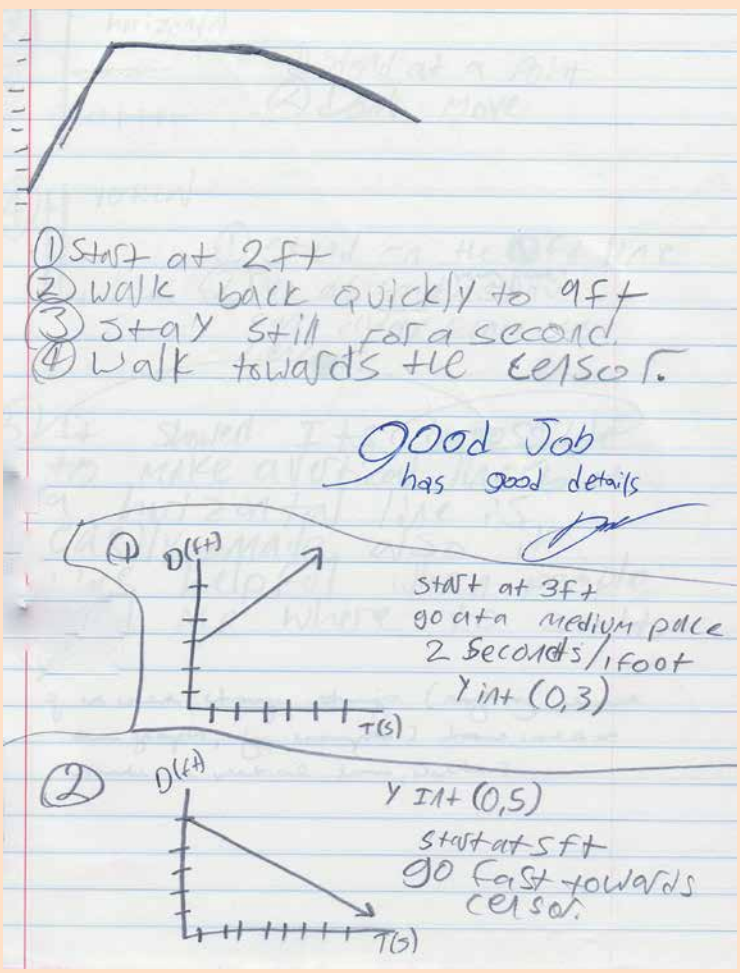
Student response 2 (*same as image in student response 1*)

Student 2 entry: I would tell the person to start right on the motion thing and take two steps back. That's the starting point. Then when the motion thing starts, back up at a kind of fast rate then stop until it starts to decline and then go forward to make the line go down.

Classmate 2 response: It's a good idea, just a little more detail.

Journal descriptions were used to help another group member match the graph.

Fig. 2 This student realized that he needed to include the *y*-intercepts and slope in subsequent entries.



assessment. It is important to note that journaling formed a type of written dialogue between students and teachers.

The exchange shown in **figure 4** represented four iterations of journaling:

1. The student's initial response
2. My response and question to her initial response
3. Her response to my question
4. My response to her further explanation of her initial response

This four-part interaction helped me better understand how Michelle was making sense of the motion sensor activity. Her mention of having to "think differently" refers to the fact that students have to think deeply before they move in front of the motion sensor to ensure that it will produce the desired graph. For example, to produce a graph with negative slope, a student starts at some distance away from the sensor and walks at a constant pace toward it. When doing the match-the-graph activity, all student movement takes place linearly in front of the sensor, but they are either walking forward, backward, or standing still. The graph produced, however, does not show a single line with one equation.

Michelle, as noted by her responses, was realizing that you had to "think differently" to garner the desired graph result. In addition to commending Michelle's realization that "different thinking" was necessary, a better response would have included an additional question, asking her to explain what she meant by "think differently":

> How did you "think differently to get the graph to show up"? Can you tell me more about what you mean by "think differently"? What

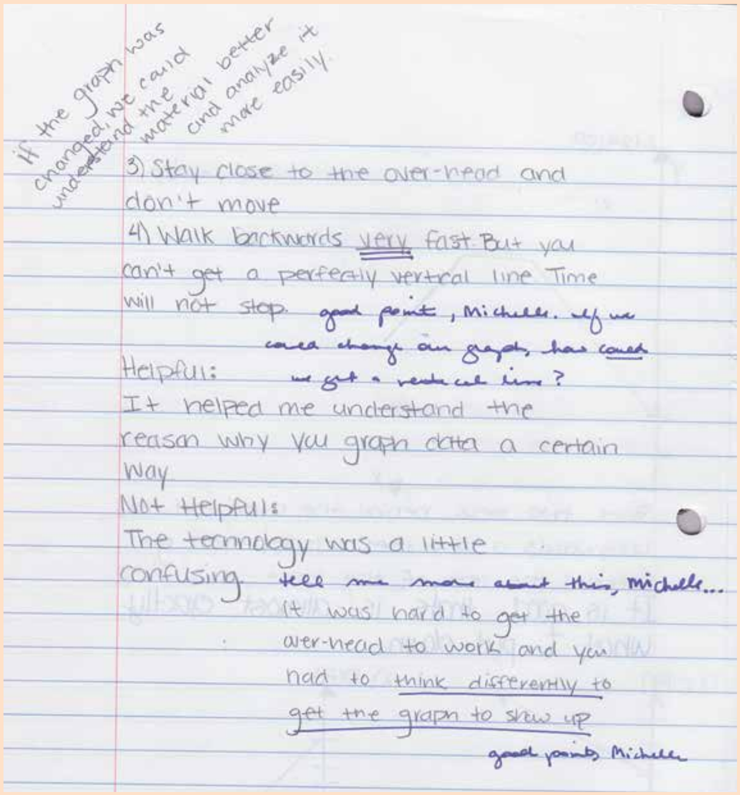
Fig. 3 After sharing their predictions and feedback, students compared one another's predictions.

Journal prompt 2: Did your classmate's prediction make sense? How did your classmate's prediction compare to your own?

Student response: Daniel's prediction made sense to me. It was different than mine, though. He included specific details about where to start using the *y*-intercept. I only guessed where to start but did not include a specific number. I see where Daniel found the *y*-intercept and so can use that next time.

Fig. 4 This journal prompt was used to close the activity at the end of the day.

Journal prompt 3: What was helpful about the CBR 2 activity and what was not? Why?



mathematical terms may you include to help me better understand?

It is worth noting that, beyond this assessment of students' developing understandings (as Michelle's writing indicates), journaling also gave me, the teacher, a personal connection with students through written dialogue, which became a recorded history of their reasoning and sense making throughout the course.

RESPONSE TYPES

The journals allowed for two types of responses: student-to-student responses (e.g., Journal prompts 1 and 2) and teacher-to-student responses (e.g., Journal prompt 3).

Student-to-student responses: Having classmates exchange journals allowed students to discuss, in writing, their mathematical ideas. It encouraged them to construct viable arguments, promote reasoning, critique others' reasoning, and engage in meaningful mathematical discourse (CCSSI 2010; NCTM 2014). I did find, however, that student-to-student feedback was not as detailed (see **fig. 1**). Similar to the examples above, students tended to agree with their classmates or ask for more detail but would not offer more specific feedback as to what detail would be helpful. I did see promise, however, in having students read and respond to one another's thinking. It allowed them time to reason not only through their own responses but also through the responses of their classmates. I also noticed as the semester continued that students would sometimes model their feedback to classmates on the feedback I was offering them in their journals.

Teacher-to-student responses: When I returned journals, I gave them a few minutes to respond in writing to my inquiries. This time allowed students to review what we had discussed the week before and further explain their previous responses. Once they had time to respond, we would begin that week's lab. The students became familiar with the routine and seemed excited to receive their journals with my feedback. I would then be able to read their new entries, based on that day's lab, as well as their responses to my inquiries from the previous lab when I collected the journals from that day.

CONCLUDING REMARKS

Journals provide a history of each student's thinking over time and allow this history to be easy to review. Although I value exit slips and find them helpful for certain situations, they tend to be lost or forgotten after I review them. I sometimes used journals in place of exit slips, which allowed one central location for both the student

Fig. 5 These journal tips encourage more detailed student writing.

- Start small because the initial implementation of journaling in a mathematics classroom can be overwhelming. Because of my schedule, students were journaling only once a week, which allowed me time to respond and gave students a routine activity. In that way, I could see if their entries improved over time.
- Do not feel obligated to respond every day. No-response days provide an opportunity for student-to-student journaling. Depending on your time constraints, have students respond to a mathematical prompt one day. The next day, ask students to exchange journals with a partner. That time is spent with the partner offering feedback. I often told students they had to write, much like a free write, the entire time (generally at least 5 minutes). This time often resulted a good record of their thinking as well as their thinking in response to their classmates' entry.
- Encourage more detail in student-to-student peer responses. Model in your own responses to students what you would like them to write. For example, if students use vague terms or phrases, or language that is at least vague to the reader, ask them to say more about a specific phrase, as I did with Michelle (see **fig. 4**).
- Show students an exemplary student-to-student exchange. Talk specifically about what makes the exchange strong. For example, the second exchange in **figure 1** lends itself to requesting more detail connecting the author's comments to time, distance, rate, and slope. The classmate can ask the author why he wrote "take two steps back—that's the starting point" and "back up at a kind of fast rate then stop." By writing, "take two steps back—that's the starting point," he is demonstrating knowledge of the *y*-intercept, but additional questions would help determine if *he* made that connection. Similarly, "back up at a kind of fast rate then stop" gives insight into his understanding of rate and slope, but questions arise when he writes "stop until it starts to decline"—will this ever happen? Questions posed (or not posed) by classmates also offer a window into their understanding on the basis of the questions they do (and do not) ask.
- Require each student to ask his or her classmate at least three questions about mathematical content. The teacher could offer a choice of mathematical terms (e.g., slope, rate) from which the students could choose to focus if students needed more guidance.

and me to review their reasoning and sense making. **Figure 5** summarizes some tips for encouraging more detailed student writing. With further development and modeling of what mathematical conversation looks like, teachers and students can continue to engage in high-quality mathematics that promotes the ideals set forth in *Principles to Actions* and CCSSM.

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