

FRAMING DISCOURSE FOR OPTIMAL LEARNING IN SCIENCE AND MATHEMATICS

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Small group worksheets

The architecture of small group whiteboarding of worksheet problems was somewhat different. In these exercises, students were usually given a fixed amount of time to represent their solution to some problem from a worksheet they had been asked to do for homework. At other times, they were solving problems that they had seen for the first time only a few minutes earlier and they had had no opportunity to consider them at any length prior to engaging with the whiteboard group. There were interesting differences in the way the activity unfolded in these two cases.

Going Over Homework – The Power of the Marker

When the activity structure was that of Going Over Homework, the group member who assumed leadership was most often the one who created the important parts of the whiteboard. It was this Decider's version of the solution that was written down, at times in spite of what other members of the group contributed. At times, some group member would insist that something be added to the solution and The Decider would capitulate and add it to what he or she had written, but, in general, The Decider maintained veto power over the other students' contributions. I have come to think of this phenomenon as The Power of the Marker. Controlling the marker was, largely, controlling the floor in the whiteboard discussion. The Decider in this setting has the deciding vote in determining what counts out of all the things that students say to each other in constructing a whiteboard representation, and she exercises this control by either writing down or not writing down what other members of the group contribute to the discussion. If there is competition for leadership in the group or if The Decider does not give sufficient attention to what other members of the group contribute, another factor enters the picture: The Power of the Eraser. This happens when some other member of the group than the scribe, picks up the eraser and erases what The Decider has written. Sometimes this will result in a transfer of the marker to the person doing the erasing, but more often it will result in a recreation by The Decider of the representation that is more in line with what The Eraser or other members of the group had in mind. The Eraser exhibits a variety of motives, often fairly benign, including neatness or clarity of expression, but sometimes the motive is clearly control over the content of the finished product. If we look at whiteboard construction in this context through the lens of conversational analysis, we see a lead individual who controls the floor, with challenges that could be considered "turn-sharking"—taking away another student's turn to speak—or "turn dolphining"—rescuing another student or saving some student from a mistake in her representation. At times The Decider voluntarily relinquished the floor to another member of the group without being challenged. When this happens The Power of the Marker is usually also transferred to this person.

Table 1

Small group whiteboarding - going over homework

Title	Role	Leader or follower?	Proactive, reactive or passive
Decider	Decides what should appear on whiteboard	Leader	Proactive

Scribe	Writes on whiteboard	Follower (when this is not the same person as the Decider)	Reactive
Eraser	Erases what is shown on whiteboard	Leader (turn as leader begins with erasing the whiteboard)	Proactive
Discussor	Discusses what appears or should appear on the whiteboard	Follower	Passive

Students' goals have a significant impact on the power relations among group members. If group members share the goal of Getting The Right Answer, this has considerable influence on their movement through the problem space as they whiteboard their solution. Often, in this case, The less certain members of the group have very little input in the preparation of the whiteboard. When it comes to the presentation of their board to the class, the Decider is the first, and frequently the only group member to speak, unless the teacher calls on some other member of the group to give the explanation. This, of course, assumes that students' goals can be inferred from what they say aloud or write down.

(A group of three boys, Juan, Jorge and Kevin, nearest the video camera is working on question number four. Jorge gets a meter stick from the back of the classroom and he holds it steady as Juan begins measuring and making a carefully spaced row of dots on their whiteboard. Then after some thought Juan writes on the board $\frac{4 \text{ cm}}{1 \text{ s}}$. He considers what he has written for a few seconds. His partners do not comment. Juan caps his marker.)

Camera operator: "How do you know?"

Juan: I measured the distance from one dot to the next and in each one was four centimeters, and since there is a dot for each second, this means that the object was going four centimeters per second.

...

(A short while later the boys are presenting their whiteboard to the class.)

Teacher: ...Okay you might you might want to pay attention in case you struggled with this on your homework...go ahead guys...

Juan: Okay, from right here, it goes one second per every dot it hits and right here it goes four centimeters from that dot to that dot, so it goes four centimeters per one second...so that's all we got for the centimeters per second.

Maria: What did you find?

Juan: Average acceleration...I mean average velocity.

Teacher: Is it accelerating?

Juan: No.

Teacher: How do you know it's not accelerating?

Juan: Cuz from there to there it goes four centimeters per second and from there to there it goes also four centimeters per second...and from there to there it goes four centimeters (points to each dot in turn) and it keeps going on at a constant speed.

Teacher: Okay. Jorge, If we looked at it ten seconds later, how far would it be from that first dot?

Jorge: I don't know. I don't get this stuff.

(CCHS 2-13-06)

In Going Over Homework, sometimes students were in discourse with each other, and at other times, they appeared to be in dialogue with themselves or with their representation. This latter was the case in the previous excerpt. If the camera operator had not asked Juan how he arrived at his answer from his representation, it is likely that he would have kept his reasoning process private. At times students talked aloud as they were constructing written representations although their words did not appear to be directed to anyone in particular. This was more common in the honors physics and community college classes and may have been related to their greater level of concern that all members of their working group understood the inscription they were constructing.

Practicing With the Model

The activity structure of Going Over Homework differs from that of Practicing With The Model in that The Decider is less apt to be the same person throughout the episode when students are practicing with the model. The marker and the floor change hands regularly during the negotiation of what will ultimately appear on the board, whether or not The Eraser intervenes. There is real crosstalk in this activity structure, with students speaking directly to one another, rather than talking to the teacher about what another student has said or written (something that occurs frequently in whole-group whiteboard presentations, as we will see in the next section). In Practicing With The Model, group members typically contribute to the discourse as co-equals, and in addition to The Decider and The Eraser, described above, other members of the group who do not fill these roles usually participate in the discussion of what should appear on the board. Both turn-sharking (the pre-empting of one another's turns to speak) and turn-dolphining (the protecting or rescuing of one another's turns to speak) may take place in these conversations but they are less about who controls the discussion than about determining what path the reasoning process should be taking.

Table 2

Small group whiteboarding - practicing with the model.

Title	Role	Leader or follower?	Proactive, reactive or passive?
Decider/Scribe	Writes what appears on whiteboard	Leader	Proactive
Eraser	Erases what is shown on the whiteboard	Leader	Proactive
Discusser	Discusses what should be shown on	Follower	Reactive

There is more erasing and rewriting in an episode of Practicing With The Model than in Going Over Homework as students try out different ideas that occur to them on the fly by writing them down. Sometimes they are writing these partially formed ideas for the benefit of other members of the group, to help them communicate what they are thinking, and at other times they are writing them down so that they can better visualize how the various elements stand in relation to one another and how they can be manipulated. This may also be an effort to manage cognitive load. If they offload their ideas in the form of written inscriptions, they can free up their working memory for other information. One side effect of this practice is that it serves as a “think-aloud” exercise that allows the other member of the group to know how the person writing is structuring their conceptual system.

When using the whiteboard in this way, as a medium for communicating partially formed knowledge structures, some students appear to prefer to ‘think aloud’ in spatial representations and others prefer to ‘think aloud’ in algebraic representations. Those whose preferred mode of written communication is algebraic are more often talking to themselves than to other members of the group. This is confirmed by the fact that although they may talk as they write, the talk is seldom directed to anyone in particular, and it is seldom answered by the talker’s group-mates.



Figure 1. Christina reasons about the problem space by constructing a diagram

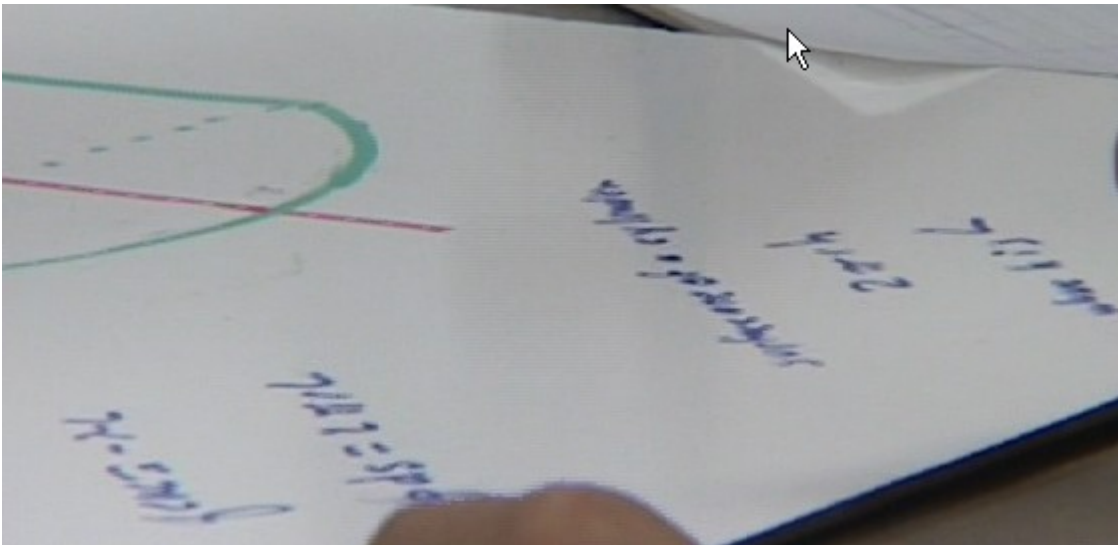


Figure 2. Gabe reasons about the same problem space as Christina above, but he uses equations.

In general, it appears that Distributed Cognition across multiple individuals occurs more often when students are Practicing With The Model than when they are Going Over Homework as the floor and the marker change hands during discourse.