

THE ROLE OF THE FACILITATOR IN PROMOTING MEANINGFUL DISCOURSE AMONG PROFESSIONAL LEARNING COMMUNITIES OF SECONDARY MATHEMATICS AND SCIENCE TEACHERS

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This report describes the construct of decentering and its influence on the discourse of a professional learning community (PLC) of secondary mathematics teachers. We used decentering as a construct to describe a behavior in which one attempts to understand the mathematical thinking and/or perspective of someone else. Analysis of data from four PLCs over two semesters revealed that a PLC facilitator's ability to decenter influenced the quality of mathematical discourse in the PLC. As a facilitator's ability to decenter increased, the discourse among members of the PLC became more meaningful. In addition, the degree to which a facilitator decentered when interacting with other PLC members appeared to be influenced by the facilitator's understanding of the topic under discussion. This research is informing the instructional design for PLCs and PLC facilitator training. The findings also have the potential to contribute to the theoretical construct of decentering.

This study investigated the mathematical discourse among members of four different professional learning communities (PLCs) of secondary mathematics teachers. In this report we focus on PLC facilitators' roles in promoting meaningful mathematical discourse among the learning community's participants. By "meaningful mathematical discourse" we mean substantive conversations about understanding, learning, and teaching mathematics. We took a design research approach in which a strategy to support PLC facilitators was continually refined as we investigated its impact on the quality of the PLC's mathematical discourse. Our findings revealed that facilitators who made efforts to understand the thinking and perspectives of other PLC members (we call this decentering) were better able to engage the members of the community in meaningful discourse. This paper describes five manifestations of decentering and their effect on the mathematical discourse among the PLC's teachers. It also illustrates the ways in which four PLC facilitators, over time, decentered, some with increasing flexibility and increasing effect on the PLC's discourse. Findings also revealed that a facilitator's level of understanding of the concept that was central to the lesson influenced the quality of the PLC discourse. This was revealed in her/his questions, choice of tasks, and discussions with members of the PLC.

Theoretical Framing of the Study

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To facilitate teachers in a professional learning community requires that the facilitator place himself in the teachers' shoes. "Placing oneself in another's shoes" is a classic instance of what Piaget (1955) identified as *decentering*, or the attempt to adopt a perspective that is not one's own. Steffe and Thompson (2000) extended Piaget's idea of decentering to the case of interactions between teacher and student (or mentor and mentee) by distinguishing between ways in which one person attempts to systematically influence another. In their telling, decentering involves the ways a person adjusts his or her behavior in order to influence another in specific ways. In that process, each person acts as an observer of the other, creating models of the other's ways of thinking. Steffe and Thompson distinguish between two primary ways in which persons interact with each other and two kinds of models that people make of others in the course of interacting. As an interactor, a person can be a first- or second-order observer of the other. They can also create first- or second-order models of the other. A first-order observer is one who interacts with another in a non-decentered mode, taking non-reflectively the assumption that the other's thinking is identical with the observer's. As a second-order observer, the observer assumes that the other person's behavior entails a rationality of its own and attempts to discern that rationality. That is, a second-order observer creates models of the other's thinking and is aware that it is a model. It is necessary to clarify that a person can be a first-order observer if the observer realizes another's thinking is different than his or her own but does not attempt to build a model of this thinking. Also, if an interactor is speaking such that he or she believes the other person understands the utterances (of the interactor) just as intended, the interactor is acting in a non-decentered way.

Methods

The data for this study was collected from PLC members who were concurrently enrolled in a three-hour graduate mathematics education course and an accompanying one hour, school-based PLC for secondary mathematics and science teachers. The size of the PLCs ranged from three to seven members, with each PLC composed of teachers from the same school. The goal of the course was to deepen teachers' understanding of rate-of-change and function through a covariational approach to teaching function (Carlson, Jacobs, Coe, Larsen, Hsu, 2002; Thompson, 1994). The PLC model in this project drew from past research on "records of practice" in which communities of teachers study student work and classroom video (Ball & Bass, 2002). The PLC activities included a lesson study component, in which a lesson was developed, implemented and observed, while the researchers assisted the teachers in collecting and analyzing data (Ma, 1999, Shimizu, 2002). Following the lesson implementation and observation, the teachers use the data collected to make revisions to the lesson.

The content focus of the PLC followed that of the course. The PLC sessions and agendas were designed to improve teachers' ability to i) engage in conceptual conversations about knowing and learning central ideas of the course; ii) discuss and assess student thinking; iii) develop inquiry based, conceptually focused lessons; and v) engage in meaningful reflection on the effectiveness of their instruction.

Each PLC had one member, selected because of her/his potential to emerge as a teacher leader, who acted as facilitator. The facilitator received 18 hours of summer training and met weekly with university faculty to plan for each PLC session. PLC facilitators were responsible

for managing the discourse during their PLC sessions. They were expected to follow a general agenda that was developed by project faculty, although they were encouraged to deviate from the agenda as needed to allow meaningful discussions to continue. Facilitators received coaching between meetings from a project leader who had reviewed video recordings of recent PLC meetings. The coach met for 30 minutes with all four facilitators once per week to offer general suggestions for improving their facilitation abilities. During the meeting the coach also asked specific questions aimed at promoting reflection about the facilitators' interactions with other PLC members in their PLCs (e.g., "Sharon, why don't you allow Mary to answer questions?" and "Dan, why are you doing most of the talking?"). These specific questions were gleaned from the data that was reviewed the previous week.

Each course and PLC meeting was videotaped. The videos were coded by two researchers who worked as a team to code all videos for a designated PLC between PLC meetings. Selected videos were discussed among the research team each week, with video excerpts related to decentering also shared with the PLC coach. During these meetings the research team identified emerging theoretical constructs in a manner consistent with a grounded theory approach.

Results

Analysis of the PLC video data revealed five observable manifestations of decentering. We have characterized these Facilitator Decentering Moves (FDM) as follows.

- FDM1: The facilitator shows no interest in understanding the thinking or perspective of a PLC member with which he/she is interacting.
- FDM2: The facilitator appears to build a partial model of a PLC member's thinking, but does not use that model in communication with the PLC member. The facilitator appears to listen and/or ask questions that suggest interest in the PLC member's thinking; however, the facilitator does not use this knowledge in communication.
- FDM3: The facilitator builds a model of a PLC member's thinking and recognizes that it is different from her/his own. The facilitator then acts in ways to move the PLC member to her/his way of thinking.
- FDM4: The facilitator builds a model of a PLC member's thinking and acts in ways that respect and build on the rationality of this member's thinking for the purpose of advancing the PLC member's thinking and/or understanding.
- FDM 5: The facilitator builds a model of a PLC member's thinking and respects that it has a rationality of its own. Through interaction the facilitator also build's a model of how he/she is being interpreted by the PLC member. He/she then adjusts her/his actions (questions, drawings, statements) to take into account both the PLC member's thinking and how the facilitator might be interpreted by that PLC member.

Tracking the facilitation abilities of the four PLC facilitators over one year revealed that two of the four facilitators made observable shifts in their ability to decenter over the year. A third facilitator was effective in promoting meaningful exchanges between the other PLC members, although he did not show noticeable improvements in his ability to decenter when interacting with his colleagues. The fourth facilitator made no efforts to decenter, nor did she make moves to

promote meaningful mathematical discourse in her PLC. In this section we describe and contrast ways in which the facilitators engaged with and used decentering in their interactions. We also discuss PLC facilitator shifts that we observed.

In Jason's early weeks as a facilitator he was observed asking general questions and made various moves (e.g., probed a PLC member to draw a picture, prompted a PLC member to explain her thinking) to promote discussions among members of his PLC. As the semester progressed his ability to promote meaningful discussions between the PLC members improved, although he was rarely observed decentering when interacting with his colleagues. Analysis of the video and other written data revealed that Jason's weak understanding of the concept under discussion was an obstacle to his decentering. At strategic moments during discourse he regularly missed opportunities to inquire about the thinking of a PLC member, although his awareness of his mathematical limitations combined with his desire to facilitate rich discussions resulted in him regularly involving other members of the PLC to facilitate meaningful exchanges, i.e., exchanges in which the interactors built and used models of each others mathematical understandings. This pattern of interaction is illustrated in the following exchange in which PLC members were discussing their solutions to a photo enlargement problem.

In this problem, a 6" by 8" photo was to be enlarged. The enlarged width dimension was given and the PLC members were asked to find the enlarged length dimension and provide a rationale for their approach. The PLC agenda also prompted the facilitator to manage the conversation so that the PLC members emerged with an understanding of the connections and usefulness of expressing a proportion as both a constant ratio and a functional relationship in which one quantity is expressed as a constant multiple of the other. (This had been the focus of the course activities just a few days earlier.) In the following excerpt Jason posed general questions to Richard about his thinking after he had constructed a written response to the question.

Jason: What would you want your students to see if you know that there is a ... there are two quantities that are in a constant ratio? What would you want your students to say or see?

Richard: That ... what I think is maybe that even though the uh difference in numbers six to fifteen and eight to twenty and like the amount ... the total amount that they want is different ... the uh I was gonna say percentage wise they went up it's the same. Like they like ... what I got was uh ... six was increased or ... yeah six is forty percent of fifteen and eight is forty percent of twenty. So they both ... so the ... so what I got was the photo enlarged forty percent like even though they are different numbers forty percent of a bigger is gonna be a bigger number and forty percent of a smaller number is gonna be a smaller number. So that even though the difference between the numbers ... that the overall way they are changing I guess is staying the same. So if I were to go even bigger than ... if I were to go from the twenty to the fifteen I still all I did ... the twenty and the fifteen and enlarge it even more its still going to be just that forty percent different ... difference.

Jason: Mm k. Now you two (points the other two members) he's your student and he just explained that to you and remember we're just talk... we're just trying to

find out what he knows about constant ratio. We are given two quantities ... k?
What are ya ... how do you want to interview him? What would you say?

First, we noticed that Jason showed interest in Richard's thinking but he did not act on the thinking expressed by Richard (FDM2). Instead, he involved other members of the PLC in questioning Richard. In doing so, Beth, the mathematically strongest member of the PLC, began questioning Richard. Her questions revealed that she believed Richard was unable to see how the fixed ratio between the two proportional quantities could be used to construct a functional relationship.

Beth: Could you also come up with a statement that would show the relationship between the height and the width that would work in any situation?

Richard: Betwe ... a relationship between the height. ... (looks at Beth)

Beth: (Interjecting) Between the length and width of this photo that would work in any situation? That you could always.

Richard: Ya. Ya ... and actually when I was ... just thinking about that ... ya know the six is ... if I were reducing it that the forty percent works what I would need to do is take uh ... six and divide that into fifteen to find out what the ... to find out what the real change in percentage was cause I was enlarging and not shrinking it what I ... what I said was if I was shrinking if I were shrinking it going from fifteen to six then I just shrunk the fifteen forty percent but I didn't necessarily enlarge the six forty percent.

As this interchange unfolded, Beth continued to make requests for responses and constructions to advance Richard's thinking toward a more connected and flexible understanding of proportionality. In other excerpts she also appeared to understand and appreciate the value of expressing the relationship between the two quantities as both a constant ratio and a functional relationship with a constant multiple. Her subsequent questioning revealed that she was relying on her understanding of proportionality and the model she built of Richard's thinking to decenter in her interactions with Richard (FDM4).

Our third facilitator, Sharon, initially did not decenter when interacting with other members in the PLC. She did not show interest in understanding their thinking. Instead, she dominated the conversations by providing explanations that were based on her understanding of the content under discussion (FDM1). Her explanations did not initially build on the thinking of other PLC members, although she did make an attempt to provide correct explanations when she believed that a PLC member was having difficulty. After only a few PLC sessions, over which time she received specific suggestions from the PLC coach, did she began to decenter when interacting with members of her PLC. She was observed listening and questioning her colleagues and appeared to develop models of their thinking, although her questions and interactions were focused more on moving them to her way of thinking (FDM3). She was acting as a first-order observer of her colleagues.

In an early PLC session, Sharon led her PLC in a discussion of the covariation of height and volume of water in a cylinder. As seen in the following excerpt, she showed no interest in understanding the thinking of her colleagues and her focus was on explaining the "correct" way to think about the problem (FDM1).

Sharon: Well, we're not necessarily comparing volume to height, but we're looking at relationship between...

Lisa: wide and narrow cylinders

Sharon: ... two variables, and in this case it sounds like wide and narrow cylinders is more appropriate than saying height and volume like we did in the box because, um, if I remember correctly, that liquids take the shape of their container, but a liter is a liter is a liter, no matter where it is. So if we take the same amount of water, aren't we taking the same volume of water and just giving it a different shape?

Lisa: Mmm Hmm. OK... So we're varying?

Sharon: So what are we varying? We're varying the height with the...

Lisa: with the size of the cylinder

Sharon: ...based on the size of the cylinder. So the height versus probably the radius...

In a later session, the PLC members discussed the photo enlargement problem described above. The PLC members had previously discussed ideas of constant ratio, scale factor, and constant multiplier in the context of proportional relationships. Subsequently, we observed Sharon probing the PLC members to help them express a proportional relationship described in terms of a common ratio as a function that relates length and width by a constant multiple. In discussions with her colleagues, she stated, "we should be able to write base as a function of height, or height as a function of base. So Anne (gesturing to one PLC member) pick one quantity, and Sally (gesturing to a different PLC member) take the other, and try to write a function." It is noteworthy that her questioning did not appear to be based on the PLC members' current thinking. Rather, her questions appeared to be for the purpose of guiding the other PLC members to her way of thinking (FDM3).

In Dan's early weeks as a facilitator he did not decenter when interacting with other PLC members. Our data revealed that although he appeared to listen to other PLC members when they spoke, he did not make an effort to understand their thinking. During the weekly coaching sessions the PLC coach pointed this out to him, and soon thereafter we noticed shifts in Dan's interactions with members of his PLC. He shifted from doing most of the talking and explaining, and very little listening, to making regular attempts to understand the thinking of other members of the PLC. He was also observed drawing on his understanding of individual PLC members' thinking and understandings to guide his questions and actions (FDM4). As one example, Dan had asked Bill to provide an explanation of his reasoning when working through a proportional situation involving scaling. At one point in his questioning, Dan (the facilitator) turned to Larry (another member of the PLC) and asked, "Are you going to let Bill (another member of the PLC) get away with all that algebra stuff without explaining what he's doing?" Dan then got distracted by his attention to Bill's solution and began to ask Bill another question. In mid sentence he realized that he had not listened to Larry's response. It was at this point that he caught himself, turned back to Larry, and invited Larry to ask Bill for clarification of aspects of his solution process. As he listened to Larry's questions and discussions with Bill, Dan made utterances that suggested he was trying to understand Larry's thinking. Dan subsequently engaged in a conversation with Larry in which he asked numerous questions that were directed at understanding Larry's thinking. His questioning demonstrated that he was aware that Larry had

his own way of thinking about this problem and that Larry's way of thinking was different from his own. The remaining utterances of this exchange revealed that Dan leveraged his model of Larry's thinking to engage in a meaningful and satisfying exchange that led to the advancement of Larry's understanding (FDM4). Dan was acting as a second-order observer in this exchange.

Karen, our fourth facilitator, exhibited extreme discomfort with the content and regularly made utterances that suggested she had not adopted the philosophies of the project (e.g., she did not value examining student thinking and expressed discomfort in exploring multiple approaches to solving a problem). She was not receptive to suggestions made by the PLC coach. The video data also revealed that she made no effort to listen to other PLC members, and on occasions when she did ask a question, it was not based on her understanding of how her colleagues were thinking. Karen was the only facilitator who showed no discernable shifts during her participation in the project. There were no instances when Karen decentered during her interactions with her colleagues. She was focused on obtaining answers to problems and expressed that she believed the goal was for each person in the PLC to get an answer. In fact, at one point during the second semester when the PLC coach encouraged her to explore the thinking of her colleagues, she questioned why one would be interested in understanding the thinking of others. As an example of Karen's approach to facilitating, we provide excerpts from an interchange that took place fairly late in the semester, in which Thomas, one of the PLC members, was discussing his understanding of an acceleration, rate, and time problem.

Thomas: Kind of like the y equals " a " t -squared plus " b " t plus " c ", and you multiply a times t squared, you have to end up with something in meters, so here you're multiplying these two things together, or dividing them, whatever, and you need to be ending up with meters per second.

Karen: See, I didn't, I didn't read it as that at all. I did it another way. (Karen then moved the discussion to a different topic.)

In this excerpt, we see Thomas presenting a procedural description for working a problem. He revealed very little understanding about the quantities or relationships in the situation. Karen did not appear to be interested in Thomas' thinking. Instead, she made a comment that focused on her approach to the problem. As was typical of Karen's actions as a facilitator, she did not seem to be interested in understanding the thinking of the other PLC members (FDM1). As such, she had no basis on which to decenter when interacting with her colleagues.

Discussion

Sharon and Dan improved their ability to decenter over the course of the year. As their ability to decenter increased, the discourse among members of the PLC became more meaningful. In particular, efforts to model other PLC members' thinking resulted in more meaningful discussions about ideas of knowing, learning and teaching mathematics in their PLCs.

The mathematical discussions in Jason's PLC also became more meaningful over the year, although these improvements did not result from Jason decentering during interactions with his colleagues. His weak mathematical understandings appeared to limit his ability to decenter in the context of discussions about mathematical ideas. As a result we found the high level of discourse in Jason's PLC to be surprising. We had previously conjectured that meaningful mathematical discourse relied on the facilitator's understanding of the content being discussed as a coherent

system of ideas to be learned. Although we continue to believe that Jason's weak knowledge of the content limited his effectiveness as a facilitator, we now realize that a facilitator's effectiveness can be enhanced by making strategic moves. In the case of Jason, he asked questions that promoted reflection and decentering by other members of the PLC, as they were encouraged to interact with each other. The quality of the exchanges that followed Jason's moves to facilitate discussions among the PLC members appeared to be affected by the decentering abilities and depth of mathematical understanding of other members of the PLC.

Implications

This research adds to the knowledge of the attributes of an effective PLC facilitator. The five manifestations of PLC Facilitator Decentering Moves (FDMs) should be useful for building a theory of PLC facilitator behaviors and discourse. They will also be useful in developing facilitator training tools and workshops. We anticipate that teachers' participation in PLCs that have a focus on decentering and meaningful communication will impact teachers' interactions with students. It is likely that as a PLC facilitator improves her/his ability to decenter when interacting with colleagues about mathematics teaching, learning and knowing, he/she will be better able to decenter when interacting with students. After participating in PLCs for a year, multiple teachers described how her/his efforts to understand other PLC members' thinking has positively impacted the nature and quality of their interactions with students. We will be video taping these teachers' classrooms during the upcoming year and will continue to investigate their decentering during PLC sessions and teaching.

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