Unpacking the Rules of Class Discussion: Young Children Learning Mathematics within a Community of Inquiry

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To promote equitable student outcomes some Bersteinian scholars advocate pedagogy that preserves the integrity of disciplinary learning, but supports interaction between knowledge fields. This learning, they contend, should be communicated through collective rather than individual endeavour. Collective endeavour can occur within communities of inquiry, which have documented potential to support students' mathematical learning. However, their impact on the mathematics education of very young children has not been explored. This paper uses data collected during an explanatory case study to demonstrate how a community of inquiry comprised of First Grade students and their teacher enables young children's mathematical learning.

The sweeping reforms advocated by mathematics educators over the last 25 years have included calls to break down the isolation of mathematics from other fields of knowledge. These calls have often been predicated on a desire to promote more equitable access to the "opportunities and options" afforded to those who can both understand and use mathematics (National Council of Teachers of Mathematics, 2000). As a result, reform-oriented curricula foreground the solution of 'real-life' problems as a fundamental purpose of mathematics education. Such curricula often rely on the investigation of real-life problems to expose students to important mathematical ideas, on the assumption that solving these problems will enable students to abstract mathematical concepts from their real-life contexts. Real-life problems are also seen as a way of demonstrating to students how mathematics is relevant to their lived experiences.

When describing her research on how a particular problem-centred and discussion-intensive mathematics program impacted the learning of Seventh Grade students, Lubienski (2004) applied Bernsteinian theory to demonstrate how reform-oriented curricula can promote invisible forms of mathematics pedagogy that privilege middle class students. Boaler (2002), however, had earlier demonstrated that reform-oriented mathematics programs do not disadvantage students from low SES backgrounds, provided teachers make certain features of mathematical discourse explicit to students. Groves and Doig (2004) demonstrated that communities of inquiry based around the practice of philosophy, a specific type of problem-centred and discussion-intensive pedagogy, have the potential to support powerful mathematical learning. These authors compared a mathematics lesson conducted with First Grade students in Japan, to one conducted with Seventh Grade students (aged 12–13 years) in Australia and found that both lessons promoted new mathematical understandings via practices characteristic of a philosophical community of inquiry. However, this research noted that the Australian lesson could not be considered typical. Research examining the use of philosophical communities of inquiry in Australian early childhood classrooms, and the impact of such pedagogy on the mathematical learning of students, remains rare. This paper describes research that addresses this gap and explains how one community of inquiry, based on the practice of philosophy, acts to support the mathematics education of young students. To facilitate this explanation, Bernsteinian theory is applied to reveal the visible and invisible features of this pedagogy as enacted with Australian First Grade students (6–7 years).

Theoretical Framework

Within Bernsteinian theory, invisible pedagogy is marked by weak classification and weak framing. Classification denotes the degree to which boundaries between particular categories of knowledge are maintained, whereas framing refers to how relationships between knowledge categories are communicated within the experience of learning/teaching (Bernstein, 1990). A weakly classified pedagogy is one in which boundaries between subjects, intellectual spaces or discourses are blurred. A weakly framed pedagogy is one in which the teacher's control over the selection, organisation, sequencing, pacing and evaluation of what constitutes legitimate knowledge is (apparently) relaxed in favour of greater student control. Invisible pedagogy is frequently cast in opposition to visible pedagogy, which is marked by strong classification and strong framing.

The concepts of classification and frame were further developed by Bernstein (1990) to enable typification of the types of discourse transmitted in schools. Most approaches to school mathematics are concerned with communicating a vertical discourse, marked by a "coherent, explicit, systematically principled structure, hierarchically organised, or [taking] the form of a series of specialised languages" (Bernstein, 2000, p. 157). Vertical discourses are strongly classified, with clear boundaries separating them from other discourses. They are also strongly framed via the careful selection, sequencing, pacing and evaluation of the knowledge and practices they contain. Vertical discourses are generally contrasted with horizontal discourses, which are viewed as more multi-layered, dependent on localized contexts and closely associated with everyday life. An example of a horizontal discourse is the complex system of obligation and exchange that might exist in a particular Indigenous community. Schools are necessarily concerned with the reproduction of vertical discourses. School mathematics, for example, must communicate knowledge about mathematics that will enable students to participate in mathematical discourse understood by the general community. However, the conviction that school mathematics should be personally useful and engaging has also led to moves to weaken boundaries between real life knowledge and more abstract mathematical knowledge, or between horizontal and vertical discourses. As a result, invisible pedagogies marked by weaker classification and framing, such as those focused on the solution of real life problems, have gained popularity.

In the past, the simple dichotomisation of visible/invisible pedagogy positioned invisible pedagogy as inherently progressive, and visible pedagogy as inherently conservative (Bernstein, 2000). However, Lubienski (2004) and others (e.g., Cooper & Dunne, 2004) have demonstrated that the adoption of an invisible pedagogy can reinforce persistent inequities in the distribution of powerful mathematical knowledge. These authors suggest that, by masking the dominant position of vertical discourse within the curriculum, invisible pedagogies produce a situation wherein student participation is evaluated against criteria that are unknown and unknowable to students from particular backgrounds. While resisting the conclusion that traditional methods, such as drill-and-practice, would be more suitable for lower SES students, Lubienski (2004) pondered how teachers could add "more visible pedagogical elements without compromising the goal of students to become mathematically confident problem solvers instead of passive recipients of others' knowledge" (p. 119) One possible solution to this problem, suggested by Bourne (2004), is the development of pedagogies that are both radical and visible.

Radical pedagogies, as categorised by Bernstein (1990), are pedagogies grounded in social psychological theories of learning that focus on the relationships within groups and how these shape learning. Unlike more conservative pedagogies, the goal of radical pedagogies is not the production of differences between individuals but the modification of relations between social groups. Radical pedagogies focus on collective access to valued forms of knowledge (vertical discourses) as students work together to learn the rules of these discourses and how they can be incorporated into their own knowledge and experiences. Within radical pedagogies, rules of pacing, sequencing and evaluation are relaxed to allow greater interaction between vertical and horizontal discourses. Certain radical pedagogies have been criticized for promoting local knowledges (horizontal discourses) to the extent that they fail to provide students with access to the important cultural capital within vertical discourses such as mathematics. These pedagogies represent a form of invisible pedagogy, where the inevitable authority of the teacher is masked behind apparently emancipatory practice. Radical *visible* pedagogies explicitly acknowledge the teacher's authority and responsibility to transmit important cultural knowledge but allow teachers and students to negotiate the space between students' real life experiences and the disciplinary knowledge that comprises cultural capital.

Research Design and Approach

This paper draws on data collected during an explanatory case study (Yin, 2003) of two multi-age classes in a school committed to the development of philosophical communities of inquiry. Over 14 weeks, the researcher conducted classroom observations that focused on mathematics learning/teaching, but included other types of learning/teaching as well. The class described in this paper was observed for 33 hours. Initial observations were documented using ethnographic field notes but once rapport had been established, 21 hours of classroom interactions were captured on video tape. The teacher described in the paper was also individually interviewed on four occasions for at least one hour, and the school principal was interviewed on one occasion for 1.5 hours. Video-tapes and interviews were transcribed, and examined together with the field notes, using a particular pattern matching logic known as "explanation building" (Yin, 2003, p. 120). This involved a series of iterations during which emergent patterns were compared to theoretical propositions to develop explanations of the phenomena under investigation. Preliminary analysis of the data collected during the study has revealed how one teacher was able to make her pedagogy more visible without diminishing the intellectual demand of contextualized mathematical problem-solving.

Building a Community of Inquiry: Mrs Kelly

Mrs Kelly is an early childhood teacher with over 25 years experience. For the last seven years she has taught at Mirabelle State School, a small inner-city school where she currently teaches a class of First and Second Graders (6-8 years). The school population of approximately 200 is comprised of middle class and low SES students, with a considerable number of students from culturally and linguistically diverse backgrounds. Mrs Kelly has a strong belief in the efficacy of students working in groups as communities of inquiry, a belief closely associated with her practice of philosophy in the classroom (see Lipman, 1980). Mirabelle School utilises philosophy across all year levels to sustain a culture of thinking deemed pivotal to the academic orientation of the school, and one to which the principal attributes the school's high results on state and national tests in mathematics and science.

The concept of a community of inquiry has its genesis in the writings of classical pragmatists such as Charles Sanders Pierce and John Dewey who espoused a philosophy of science centred on inquiry, most productively occurring within a community of investigators. Within such a community of inquiry, individual capabilities combine to unleash the transcending power of collective endeavour towards the solution of problems (Shields, 2003). A community of inquiry has three features:

1. A focus on a problematic situation or question;
2. The application of scientific method; and
3. Democratic participation (Shields, 2003).

The use of philosophy at Mirabelle School is overtly aligned with the development and maintenance of a community of inquiry. In lessons dedicated to the practice of philosophy, stories are used to stimulate children's thinking and generate questions for discussion. These questions are then discussed by the class, with the teacher acting as a guide to shape the forward movement of inquiry. The children are frequently reminded of the behaviours necessary for participation in the community of inquiry, which are listed on a wall chart and referred to at the commencement of philosophy sessions, during philosophical discussion or during post-discussion reflection.

Community of Inquiry

How well were we reasoning?
-Did we give good reasons?
-Did we give counter-evidence examples?

Were we listening?
-Did we avoid side conversations?
-Did we respond to what others had said?

Did we search further?
-Did we understand things better?
-Was it helpful talk?

How well were we thinking?
-Expressing our ideas well
-Giving analogies

Did we respect each other?
-Listen closely.
-Take each other's ideas seriously.
-Be considerate.
-Be sensitive to others' feelings.

*Were we self-correcting?
-Changing our minds

Figure 1. Wall chart: Community of inquiry

Students are expected to contribute their own ideas (or hypotheses) in response to questions under discussion, which can be challenged or supported by any other member of the class — provided they can provide support for their point of view. The excerpt below documents the teacher's guidance of one particular philosophical discussion, as she re-states a question generated by one child in response to the story "Dinosaurs and all that rubbish". In this story, dinosaurs return to Earth to rebuild it after it has been damaged beyond recognition by humans.

Mrs Kelly: Now, if we look at Michael's question. Why do people spoil something that people really appreciate and admire? A place you can go and share with others?

Robin: Maybe some people don't think of others, only themselves.

Michael: I agree with Robin, because it was such a great place back then, and people didn't think about others.

The next excerpt documents a later exchange, in which another student, Courtney, challenges an idea put forward by one of her classmates, Max.

Courtney: I disagree with Max….What was your point, Max?

Max: People shouldn't destroy ever.

Courtney: Sometimes you might not destroy it all down. You might destroy it once. I never knew anybody who destroyed everything.

While the teacher guides the substance of the philosophical inquiry, she simultaneously teaches students the procedural aspects of philosophy. Students learn strategies such as using analogies and developing criteria, which they practise using thinking exercises. They then use these strategies to build supporting arguments for positions taken in response to problems or questions. Procedures and protocols practised during philosophy are applied to inquiry across a range of subjects, including during mathematics lessons, when students come together to discuss problems, share preliminary findings, or form conclusions. The following extracts from classroom observations show how, by conducting mathematical investigations within an established community of inquiry, Mrs Kelly was able to develop pedagogy that was both radical and visible.

The Pattern Necklace: A Cultural Artefact

During individual interviews, Mrs Kelly stated that, in line with the ethos of a community of inquiry, effective mathematics learning and teaching should always begin with a real-life situation that is problematic. In the lesson described in this paper, the problem faced by a group of First Graders is how many beads of each colour will be needed to make a twelve-bead necklace of their own design. The problem is connected to the class' exploration of crafts from many cultures, in anticipation of a culminating transdisciplinary task in which students must prepare an art or craft object and discuss the physical, social and cultural features of that object. The lesson begins with all children seated in a sharing circle. Mrs Kelly is seated at the top of the circle and has just finished talking about necklaces the children have brought in from home and discussed during previous mathematics lessons. She continues:

Mrs Kelly: [Today] we're going to be making our own necklaces…in a mathematical way, so I'm glad that you know when something is symmetrical and when it isn't. I'm glad you know when something's in a pattern, and when it isn't…because that's what you will have to show with your necklaces that you're going to make. We're going to be making necklaces with twelve paper beads. And we're going to have to put twelve paper beads into a pattern.

Prior to this, Mrs Kelly acknowledged horizontal discourses impacting the way cultural artefacts are understood and appreciated. For example, she talked about how valuable a necklace was to her because it reminded her of her travels. In the excerpt above she draws a boundary between those horizontal discourses and the vertical discourse to be communicated, ensuring that mathematics is not merely encountered during the lesson, but clearly identified as the point of the activity. The specific relationship of concepts of symmetry, pattern and number to the discourse of mathematics is also noted. This strengthens the classification of the vertical discourse, making it visible, while revealing connections to aspects of horizontal discourses previously discussed. Next, students were asked to consider their proposed designs and posed a related mathematical problem: "How many beads of each colour will you need?" James, a student identified as gifted, responded thus:

Mrs Kelly: Who else can think of a pattern that you could put out there? James, what would you be thinking it might look like?

James: Um… red, orange, blue, green, red, orange, blue green, red, orange, blue, green.

Mrs Kelly: Ok. Do you know how many red, orange, blue, greens you'd have to put out if there's twelve altogether?

James: Um, four. No, three.

Mrs Kelly: You'd put out three orange, blue, red, greens? How'd you work that out?

James: Um, I'd put… you put blue, red, orange green once. Then you do it another time, that's eight. Then you go one more time, that's twelve.

Mrs Kelly: Oh! Wow, James! He's thought that out in his head before he's actually even experimented! So he's said he would put out red, orange, blue, green. He said "That's four", and he'd have to do that three times to make twelve altogether.

In visible radical pedagogy, thinking is a group as well as an individual enterprise. In the sharing circle, James acts as the group's proxy as he models one way of thinking about the problem. By accepting and integrating James' example into instruction, Mrs Kelly weakens the framing of the communicative context by enabling student participation in the selection of what constitutes legitimate communication. Following James' input, another student (Hamish) indicated his intention to make a three-colour pattern, but had difficulty determining how many beads of each colour he might need. In response, Mrs Kelly asked James, Hamish and another student to represent their patterns in the centre of the sharing circle. Hamish put a three-colour pattern out three times, making nine blocks altogether. Mrs Kelly responded by moving to the centre of the circle and coaching Hamish while the others watched:

Mrs Kelly: Oh, it only makes nine Hamish? We want twelve… …Hamish, can you put them out in that pattern, blue, yellow, black, and we'll see if we can do something…

Hamish: Oh, I've got something. I'll just take away one colour.

Mrs Kelly: No, no… Hamish. Leave it there. Everyone move back into the circle… What's the next part of your pattern?

Hamish: Black, yellow and blue again?

Mrs Kelly: How many did you bring down each time? How many have you still got?

Hamish: I should take away one, and keep…

Mrs Kelly: Hamish, can I just show you? Leave it where it is. Ok, everyone looking? Hamish. You said there's three (pulling down three blocks). Black, yellow, blue again (pulling down another three blocks).

Hamish: Six. (*Mrs Kelly pulls down another three blocks)*

Hamish: Nine.

Mrs Kelly: What three could I put there to make twelve?

Hamish: Blue, yellow, black.

Mrs Kelly: (*handing Hamish the box of Unifix*): Would you like to do it?

By allowing Hamish to articulate an erroneous hypothesis to the group, and then test it in the context of the community of inquiry, Mrs Kelly relaxed the pacing and sequencing of the lesson to explore the additive function of patterning in depth. Hamish, as a representative of the group, was assisted to make connections between and adjustments to his own common-sense reasoning and the vertical discourse of mathematics, as made visible in the patterning exercise. Rather than relinquishing control, Mrs Kelly retained authority to communicate important aspects of the vertical discourse of mathematics by showing Hamish where he was going wrong and supporting him to more effectively practise mathematical reasoning.

Conclusion

The lesson described is typical of the learning/teaching that occurs within the philosophical community of inquiry led by Mrs Kelly, which exemplifies the type of discussion-intensive pedagogy advocated in reform-oriented classrooms and questioned by Lubienski (2004). However, when Lubienski (2004) concluded that the pedagogy in her reform-oriented, discussion-intensive classroom was largely invisible, and as such disadvantageous to students from lower SES backgrounds, she described her teaching practice thus:

> Although I took primary responsibility for guiding our conversations, I tried to avoid being the person who decided if ideas were sensible. I had talked with students on several occasions about wanting them to learn to think for themselves but I did not talk specifically about how my pedagogy was supposed to help them with this. (Lubienski, 2004, p. 118)

This is very different from what occurs in Mrs Kelly's classroom. Through its practice of philosophy, Mrs Kelly's class has learned and the behaviours essential to the formation and maintenance of a community of inquiry. In the pattern necklace lesson, these behaviours are utilised to support investigation of an articulated mathematical question. Students were expected to formulate hypotheses in response to the question before testing and sharing these with others. Some hypotheses were tested in the context of the group so that students could learn and practice strategies useful for the upcoming task. Because of the culture of thinking developed within the class, students knew that they were expected to explain and justify their reasoning to others. To do this, they could draw on their knowledge of the linguistic and social rules of classroom discussion developed through the class' practice of philosophy.

From a Bernsteinian perspective, Mrs Kelly maintained the classification of horizontal and vertical discourses and made the evaluative rules of classroom discourse more visible, while relaxing the pacing and sequencing of the lesson's communication so that students could explore the content identified as part of the vertical discourse of mathematics, and important to their solution of the real-life problem at hand. Bourne (2004) suggested that one way to increase the visibility of radical pedagogies is via the "managed introduction" of horizontal discourse (p. 66). In Mrs Kelly's class, horizontal discourses are viewed as a starting point, and the introduction of vertical discourse is carefully managed via the examination and interrelationship of both types of discourse. Mrs Kelly's class enacts a radical visible pedagogy with potential to enable very young students from diverse backgrounds to tackle the complex interrelationship of vertical and horizontal discourses present in real life problems, while ensuring that mathematics remains at their heart.

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