

Teacher Development for Inquiry Based Instructional Practice in Mathematics: A Poststructuralist Postscript

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In this paper I argue that teachers of the twenty-first century need radically reformed professional development experiences if they are to teach in inquiry-based ways consistent with views of learning mathematics as an active, social and constructive process. By carrying out a comparative poststructuralist analysis of two teaching/learning interactions [from a paper authored by Manouchehri and Goodman (2000)], I go beyond the extant argument about the importance of teachers' mathematical and pedagogical knowledge and new images of teaching to suggest that additional factors may need to be considered as part of the professional development process. From a poststructuralist perspective I argue that the teacher's unspoken but influential *knowing* about learners and learning must also be considered and addressed as this impacts heavily, and often conservatively, on practice. Though contentious, the implications for professional development are contemplated.

Introduction

Although it has been argued that learning mathematics *without* understanding has long been an outcome of school mathematics instruction (NCTM, 2000), in the twenty-first century understanding has become imperative. This is so because well-connected, conceptually grounded mathematical ideas are seen to be more readily accessed and flexibly used in new situations. In the classroom, inquiry based instruction is advocated for its ability to actively engage students in tasks and experiences that lead to understanding through deepening and connecting their knowledge (Australian Education Council, 1990; Boaler, 1998; Brown, 1999). However, although inquiry based teaching/learning engagements are prized, the contextual and personal conditions of a teacher's acceptance and implementation of such practices are rarely researched beyond taken-for-granted understandings of the conditions of teacher change and development.

Manouchehri and Goodman (2000, p. 29) author a paper wherein they clearly demonstrate that a teacher's mathematical and pedagogical knowledge influence instructional practice; they show, with reference to two teachers Gina and Bonnie, that each teacher's content knowledge shaped expectations of students, their curriculum decision making and the teaching/learning interactions:

In the absence of a detailed understanding of mathematics and knowledge about mathematical connections on the part of the teacher participants in this study, even sincere attempts at creating an inquiry-based instruction were futile.

While the authors make an important point, I am not convinced that such arguments tell the whole story of what needs to be considered relative to professional development. It may be that inquiry-based instructional practice is premised not only on the content knowledge a teacher has or does not have, and the images of teaching they carry with them or envision (Manouchehri and Goodman, 2000), but also on their constituted *knowing* of the nature of learners and learning mathematics (Lather, 1991). It is argued in this paper that these constituted knowledges are extremely difficult to interrupt as they are beyond the

realms of cognitive reconstruction and require special attention in teacher development programs.

In adding a poststructuralist postscript to the analysis of interactions in Gina's and Bonnie's classrooms, I attempt to show that there is something in the *quality* of the teaching/learning interactions in the two classrooms that affords (or not) students the space to establish themselves as inquirers; this qualitative difference I argue has as its foundation differentially constituted views of learners and learning on the part of the two teachers in the study. I put the case that while Gina frames her practice with a view of mathematics and learners as always mobile, moving and *in process* Bonnie manages to inhibit inquiry by striving for the 'one correct answer' and her incorporation of romanticised notions of students and what it means to teach. In the concluding sections of this paper I contemplate the hurdles to be expected and overcome in having Bonnie, and others like her come to know mathematics, and how it is learned, differently.

Looking at Teaching and Learning Through a Poststructuralist Lens

Although institutionalised education is currently premised on notions of individuals as naturally autonomous and rational, this does not hold in poststructuralist thought where the person is the effect of a production, a multiple and often contradictory being. Each person is constituted, and actively constitutes him/herself through various discourses which promulgate certain 'truths' and suggest appropriate ways of acting and making meaning. In the mathematics classroom, Gina and Bonnie and their students are positioned in a three-dimensional constitutive space where relations of power relative to teacher/student identities, knowledge and authority intersect and overlap to produce, or not, inquiring habits of mind and robust mathematical understanding. In the first part of this paper I examine how, in this three-dimensional space, Gina's and Bonnie's invisible but powerful *knowing* about mathematics, about who can learn it and how it is taught, is played out and constitutes (a substantial part of) the students' experiences of what it means to learn and do mathematics.

In the second part of the paper I attempt to think about what it might mean to have teachers *come to know* learning and teaching mathematics differently; what might be the professional development implications of a view of teachers as also constituted through past and present discursive practices of the classroom and professional development programs. Teachers' implementation of inquiry based instructional practice requires new *ways of being* in mathematics education centred around new interactional patterns that are sensitive to student voice and experience and ways of making sense in/of mathematics. Such interactional patterns do not sit comfortably with many teachers who, through past experiences of school mathematics, have *come to know* learners as rational individuals who merely need to remember and reproduce the facts, skills and procedures the teacher demonstrates (Foss & Kleinsasser, 2001). How might teachers be encouraged to move 'outside the square' of established (constituted) comfort zones to embrace very different teaching/learning partnerships that generate robust mathematical understandings and student engagement in inquiry-based learning processes? Before addressing this question in more detail, I analyse and compare the interactions in two classrooms to reveal their constitutive (of teacher and learners) and constituted (by teacher and learners) nature.

Analysing Teaching/learning Interactions

From a poststructuralist perspective, inquiring habits of mind are constituted through classroom and other socio-cultural discursive practices; they are not personal attributes or attitudes as understood to be the case in humanist understandings of the individual. This being the case, it is important that discourses, in how they operate, position learners as respected, valued and competent in speaking and writing the commonly accepted ‘truths’ of the discourse and in going beyond these to forge something new (adapted from Davies, 1991). In mathematics education it is important that students, and as will be addressed later, the teachers, come to see themselves as agentic, able to act in powerful ways in the discourse. In the sections below I make the case that Gina realises the conditions of inquiry for students while Bonnie does not. I then attempt to show how each teacher’s (previously constituted) relative understandings of learners and learning impact on classroom practice.

Gina’s Class

Gina: What is the best way to create two congruent figures?

(Many students raise their hands. Gina asks one student to respond.)

T: I can trace the figure.

J: Yeah, like put a piece of paper on top and just copy it...we know that they are going to be the same thing.

Gina: Let’s do that together and see what we get. *(She places a transparency slide on the overhead projector and draws a rectangle. Placing another transparency on top of it she traces the rectangle with a different color marker.)* Okay – Let’s see – what do you notice about the two shapes that we have here? *(Pause)* How are they similar?

K: They look exactly the same –

Gina: What else? Tony?

Tony: I don’t know – they are just the same – Like they are just copies of each other.

Gina: Let’s go beyond that and try to describe what we see in terms of what we have talked about in the past – Like, what can we say about their angles? What can we say about their perimeters? What can we say about their areas? *(Students shout out that they are the same.)* Right you guys – this is really cool – Their areas are the same, their perimeters are the same, their angles are the same, and the length of their sides are the same – have I missed anything Jacquie?

J: Nope –

Gina: Good – Now I want you to think about situations when we have two things that look alike but are not exactly the same size – Let’s forget the examples in the book and think of real life situations – What do you think? *(Pause)*

S: Like in the movies?

L: Oh, yeah – in the pictures too. *(Other students nod their heads in agreement.)*

Gina: Cool! So when we go to the movies what we see on the screen is actually similar to those images that we have on those little films... Why do you say they are similar?

H: They are the same people only bigger –

Gina: Tell us more Hillary –

H: Well, it is like Tom Cruise but a whole lot bigger – His face is bigger, but the same thing – His body is the same thing, only bigger –

Gina: Right – All the detail is there only bigger – But could we enlarge his legs say 10 times and his head, I don't know, say only 5 times? (Silence) What would be wrong with that?

Jenny: It won't be right – I mean, he won't look right – Not as good looking as Tom Cruise (laughs).

Gina: What else? Who else has something to say about this?

K: I think that it won't look right because if we make his legs bigger say ten times then we need to make his head also ten times – I guess that is what it is – If we don't enlarge it the same way for all parts it is not gonna look right – It won't look like him anymore –

Gina: What do you think Sam?

S: He would sure look funny – (laughs) I think some parts of him will be similar but not the whole thing –

Gina: How can we make sure that when we have two shapes, they are similar?

P: I guess we can check to see if it is bigger or smaller the same amount on all parts.

Gina: Good idea – Let's see if we can do what P said – (She turns on the overhead projector and projects the rectangle she had drawn on the transparency on the screen.) Do you think these two shapes are similar? (pointing at the one on the screen and the rectangle on the transparency)

D: I think so –

Gina: How can we be sure?

D: It is the same thing only bigger?

Gina: How much bigger do you think the one on the overhead projector is? (Students decide that they want to measure each rectangle first. Gina asks them to do so and also to look at the perimeters and areas of the two figures and to decide whether there is a relationship between the two sets of data. She also encourages students to move the overhead projector and consider other cases.) (Manouchehri and Goodman, 2000, pp. 24-26)

My reading of Gina's teaching is that she manages to orchestrate the conditions of inquiry (Davies, 1991). She creates a classroom space where both the mathematics and the students are valued, and where each is in the process of formation or construction. She attempts to authorise student voice and ways of making sense of experience. Gina begins the lesson: "Let's do that together and see what we get". She invites the students to join her on an intellectual and social/emotional journey that could go off in any direction. Gina demonstrates her agency with the mathematics and in the discursive conversation by stating: "Let's forget the examples in the book" and invites student participation: "Have I missed anything, Jacquie?" By largely avoiding closed questions, preferring rather questions of the form: "Tell us more, Hillary" there is no pressure for students to come up with the one 'correct' answer. Rather students are given the time and space to reason in a

safe yet challenging context: K reasons: “I guess that is what it is – If we don’t enlarge it the same way for all parts it is not gonna look right – It won’t look like him anymore -; P: “I guess we can check to see if it is bigger or smaller the same amount on all parts”. Students are also authorised to make sense of the mathematics in ways that are meaningful to them: “Students decide they want to measure each rectangle first”. It would appear that Gina interacts with her students in such a way that they are developing inquiring habits of mind and coming to know themselves as competent doers and users of mathematics.

Bonnie’s Class

Problem: It is Karen’s birthday and Karen’s mother bakes 13 cookies. People at the party take turns picking cookies from the tray. If Karen takes the first cookie and the last, how many people were at Karen’s party?

Bonnie had intended to use the ‘cookie problem’ as a part of her warm up segment and was prepared to begin a unit on fractions for the day. The events of the session, however, not only forced a change of plans on her part, but also created a situation in which she was uncomfortable with the mathematics discussion she had to lead in class.

Bonnie assigns the warm-up problems. Following an 8 minute work time, Bonnie asks students if they are ready to present their solution to the group. Several students raise their hands. S1 explains that his answer is 12 – it seems that the answer is consistent with what Bonnie considers as the correct answer. “Good work S1. Does everyone agree with the solution?” Bonnie asks. S2 suggests that her answer is 2 and not 12. Bonnie looks at the problem again – She asks the student to go to the board to explain her strategy. S2 draws a circle and places 2 lines around the circle...she counts starting from the line she identifies as Karen up to 12 going around the circle 6 times – Bonnie looks surprised. She is looking at me for assurance. “What do you think class? Which do you think is right?” S3 suggests that his answer is different from the others and that he thinks there are 3 people at the party. Students are quiet – Bonnie asks S3 to show his work – S3 using the same diagram S2 has used, suggests adding another line around the circle representing another guest and shows by the means of counting and going around the circle 4 times why he thinks the correct answer is 3. “Do you see what I have done?” he asks Bonnie – Bonnie nods her head in approval – S3 goes back to his chair – Bonnie looks puzzled and continues to read the problem. A few seconds of silence pass as students look at Bonnie to tell them what to do – In the meantime...[some data omitted] S5 and S6 simultaneously ask Bonnie why their answer of 12 could not be correct. Long pause by Bonnie as she looks at the solutions offered by the group. “I think this was a really good problem. We all have different answers and they all sound right...(Pause) This is real problem solving, you see! You all did very well class”. S3 asks which answer he should record on his paper - “I don’t understand why these answers all can be right – I still think mine is right! Should I write my answer or everybody else’s?” “Just put down all the answers so you could think about it some more”, Bonnie responds. All students begin recording the answers on their papers. (*Manouchehri and Goodman, 2000, pp. 19-20*)

Although Bonnie and her students are ostensibly involved in inquiry based practice, they together establish and maintain a competitive search for the ‘one correct answer’. Once this culture is in place it is unlikely that students will want to engage substantively in exploratory processes, as they come to see their task as getting as expeditiously as possible to the answer. Though the students are asked to explain their answers, they are not able to experience themselves as in any way competent because they do not get to know whether

what they have produced, or how they have produced it, is acceptable within the discourse. It could be argued that the substance (as argued by Manouchehri and Goodman, 2000) *and* the experience of the interactions in Bonnie's classroom militate against deep inquiry on the students' part. While Bonnie is clearly not aware of the powerful mathematics that could ensure from involvement in this activity, the quality of her interactions with students is also hampered because of her constituted *knowing* of what it means to learn (and teach) mathematics.

How the Teacher's Constituted *Knowing* Impacts on Practice

Gina's joy with/in mathematics (*with* mathematics as a discipline or discourse worthy of study and engaged investigation, and *in* the discursive practices as teacher) catches up the students and carries them along: "Right you guys, this is really cool". She does not shy away from taking a proactive role to facilitate knowledge growth; my guess is that Gina knows from personal experience the joy of intellectual and emotional challenge and resolving a problem. The students are formed in discursive practices that uphold mathematics as really 'cool'. As well, the students' already constituted identities are recognised and brought to bear on the task at hand; in this case they bring in Tom Cruise and create a comfortable relevance in the activity. However Gina does not subscribe to notions of learners as needing to be protected and coddled; while she is sensitive to their prior experiences and their needs to make sense for themselves, she states: "When they are in my mathematics class, they are there to learn mathematics – My job is to make it accessible to them and to help them to see that they can do it" (p. 10).

Gina recognises her students as mathematicians in-the-making and endeavours to have them see themselves as legitimate participants in the discursive community; her stated purpose is to help students grow mathematically and to communicate mathematics (Manouchehri and Goodman, 2000, p. 9). I would argue that these facilitative qualities in Gina's practice are not merely cognitive and conscious, but are based on constituted *knowing* of mathematical knowledge and learners as always growing and in process. Gina knows the mathematics and she is also comfortable with inquiry-based, investigative ways-of-being in mathematics that are based on new power relations. However, it could be, as most surely it is for many teachers, that although they know the mathematics, the new instructional patterns that celebrate student voice and ways of making sense of mathematics feel threatening and do not sit well with constituted knowledges of how mathematics is learned.

Bonnie, quite distinctly from Gina, appears to base her practice on understandings of learners that effectively preclude their engagement in extended inquiry. Bonnie seems to equate active engagement with learning mathematics. She says that she seeks to accommodate students both emotionally and intellectually (Manouchehri and Goodman, 2000, p. 4) and she is happy with a lesson "when she is able to engage nearly all the students and have them share their thinking" (p. 22). Bonnie often engages in 'ability' talk; she speaks of her "least able kids" (p. 4) and expresses "dissatisfaction with the students' inability to understand..." (p. 18). Bonnie's way of dealing with a perceived lack of understanding is to do more of the same or similar examples (p. 26). A humanist, individualistic notion of learners and romantic notions of teaching appears to cause Bonnie to take for granted that the growth of mathematical knowledge, and a positive disposition towards mathematics, will automatically grow out of activity, however poorly conceived. Bonnie, basing her instructional practice on notions of a learner with the inherent potential to be self-motivated and autonomous, sees her role as teacher to be one of 'bringing out'

this potential (Usher and Edwards, 1994).

Throughout the lesson Bonnie maintains a position of authority, in the sense of authorship of classroom interactions and actions, even though she struggles with the content of the lesson herself. The students are actively involved, they do get up to explain what they have done and they do ask questions; however, these acts are invariably focused on the answer and not motivated by a wish to participate in and contribute to a continuing conversation around a mathematical idea. What happens is that any dilemmas or problems that arise for the students are about their performance rather than the mathematics (Lave, 1997). For example, S3 asks: "I don't understand why these answers all can be right – I still think mine is right!" and "Should I write my answer or everybody else's"? Students invariably defer to Bonnie's authority: "A few seconds of silence pass as students look at Bonnie to tell them what to do". Bonnie positions the students in such a way that they are dependent on her and she does not allow their ideas and experiences to broaden and strengthen the communal learning process; although she hears their ideas, these ideas are not used to nourish and enrich learning. Bonnie clearly takes for granted, in that she related to the researchers that she was happy with this lesson, that active engagement unproblematically advantages learning.

An interesting and perhaps controversial issue arises here concerning the affective dimensions of context and the effect on student engagement in inquiry based learning. For example, Bonnie appears to have a warm and caring nature and indulges in more student praise than Gina: she says "Good work S1". "I think this was a really good problem. We all have different answers and they all sound right...this is real problem solving, you see! You all did very well class". But a poststructuralist reading of identity constituted through classroom relationships of power would suggest that agency (*with* the mathematics, and *in* the discursive relations) is what matters. For students to act in agentic or investigative ways they have to feel confident with the mathematical content and their ways of speaking and representing mathematics and they have to have a sense of themselves as able to go beyond what is given to produce something new. One can only wonder at the effect on students when the mathematics is mystified yet they are constructed as somehow deficient; for example, when Bonnie suggests *they* need to "think about it some more". Bonnie does not pause to question the qualitative status or effects of her particular interpretation and application of inquiry-based instructional practice!

Implications for Teachers' Professional Development

Where relationships of power are not seen or are ignored in classrooms or professional development programs, little about the quality of interactional patterns is likely to change. This is because any blame or implied lack is readily sheeted home to the supposedly autonomous, rational individual who chooses not to act appropriately. In Bonnie's classroom she proclaims that the students need to 'think about it some more'; similarly, teacher development programs assume that teachers merely need to cognitively reconstruct the mathematics and pedagogy relative to the new pedagogical practice. For example, Manouchehri and Goodman (2000), proffering the view that learning is an active, social and constructive process for students and teachers, suggest that teachers *need* new images of teaching and enactment strategies; they *need* 'authentic' experiences that engage them in conceptual explorations of mathematics, and assist them in constructing a mathematical and pedagogical point of view that would serve as a foundation for successful implementation of reform-based curriculum and instruction (p. 31). While I agree that these experiences could assist teachers with the *substance* of what is taught in the

classroom, from a poststructuralist perspective I make the point that this is, as Manouchehri and Goodman (2000) have stated, just a foundation. It may indeed be a shaky foundation or a robust one; depending on the *nature* of the professional development experience and the constitutive effects. Teachers will act in powerful or powerless ways depending on how they have been able to establish themselves as generative professionals in the classroom and professional development process. A too ready assumption of the easy implementation of change or application of (re)constructed knowledge traps practitioners and researchers alike into the very stasis we are trying to move beyond; in deferring to commonsense or taken-for-granted understandings of the efficacy of rational thought and the ‘naturalness’ of autonomy we may be blind to those power-related factors of instructional practice that militate against change.

Contemplating change from a poststructuralist perspective necessitates that we not only consider the thinking individual, but also the operation of discourse(s) (such as those of teacher development). Discourses comprise “historically, socially and institutionally specific structures of statements, terms, categories and beliefs” (Scott, cited in Adams St Pierre, 2000, p. 485) and organise ways of knowing into ways of acting in the world. A new discourse, with new ‘truths’ and ways of interacting is needed to bump into, to confront and interrupt the operation of existing discourses in the interests of redefining notions of what it means to learn and teach mathematics for the twenty-first century. New discourses can supposedly re-write the world as teachers are configured at the intersection of multiple intersecting discourses, living/acting in an between discourses finding comfortable spaces and investments (not necessarily conscious) in discourses that enact new truths and ways of operating. Change is accomplished as a result of contradictory positioning, due to the co-existence of the old and the new; every relation and every practice to some extent articulates such contradictions and therefore is a site of potential change as much as it is a site of reproduction (Hollway, 1984, p. 260).

Conclusion

My argument and analysis in this paper is founded on the idea that teaching/learning relationships are productive; they are productive of intellectual knowledges and simultaneously constitutive of participants. In relation to teacher development, it is important that the teachers not only construct new conceptual understandings and mathematical connections, and become acquainted with new images of teaching and learning (Manouchehri and Goodman, 2000) but also that they are positioned in ways that afford them the space to establish themselves as agentic and generative professionals. In other words, programs that operate solely on knowledge transmission, that cement traditional power relations, are probably not useful. A special effort must be expended to engage teachers in a ‘border pedagogy’ (Davies, 2000) that re-visions taken-for-granted understandings of what learning and teaching might be. This is undertaken not on the assumption that the teachers will act upon these new understandings, but rather that through engagement in this alternative discourse they will sense how the process of *coming to know* is socially produced, and contingent, tentative, provisional. A re-culturing of professional development would embrace the practices mooted by Manouchehri and Goodman (2000) and go beyond these to emphasise new dialogic forms celebrating teacher led inquiry; teachers’ initiation of ideas and ways of making sense of experience. Over time, it may be constitutive of teachers who have a sense of themselves as able to go beyond the taken-for-granted to forge something new in mathematics education. As Kilpatrick and Silver (2000) make clear, changing the ways teaching and learning

mathematics is done is not a technical problem - it involves a form of social change. This, I would add, may take some time and dedicated thought beyond the pale of contemporary and comfortable research methods!

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