
REFLECTING ON PARTICIPATION IN RESEARCH COMMUNITIES OF PRACTICE: SITUATING CHANGE IN THE DEVELOPMENT OF MATHEMATICS TEACHING

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The relationship between the development of the teaching of mathematics and the classroom teaching of mathematics is of considerable interest to teachers and university academics. This article reflects upon the nature of the participation of teachers and university academics as they participate in research communities of practice that use inquiry as a tool to engage with change and development. Conclusions are drawn in terms of the nature of the relationship of university academics to classroom teachers within a research community of practice.

Introduction

For decades educational researchers such as Brown and Duguid (2000) have maintained that the professional development of teachers is best situated within their own practice and best supported by local communities of practitioners. In this paper we critically reflect on this claim by examining the shifting identities of a teacher of mathematics and a university academic as they participate together in different communities of practice – a local research community of practice composed mainly of classroom teachers and an international research community of practice composed mainly of university academics. We suggest that the differences and tensions created by maintaining membership in both these communities create possibilities for professional growth and new insight in mathematics education that transcend the local community level.

The notion, ‘community of practice’, has been described as “a set of relations among persons, activity, and world, over time” and as being “an intrinsic condition for the existence of knowledge ...” (Lave & Wenger, 1991, p. 98). It is through participating in the practice of the community that members learn what it means to be a competent practitioner and how they can contribute to emerging practices (Brown & Duguid, 2000).

The notion of ‘participation’ that is deployed in this paper arises from the work of Vygotsky and contemporary sociocultural theorists. According to Vygotsky (1987), learning has its origins in mediated social action and the deployment of tools such as language and other mnemonic systems. Learning results from ongoing engagement in social contexts and is mediated by ways of knowing, doing, and valuing that are socially situated. It is through participating in situated practice that an individual is initiated into

the culture of a particular community of practice. In this process a person's relationships to others, to activity, and to the world are transformed over time to show both congruence with and critique of the ways of knowing, doing and valuing of a community (Lave & Wenger, 1991).

In elaborating forms of initiation into the culture of mathematics, van Oers (2002) maintains that discourse plays a pivotal role in raising people's awareness of and engagement with the practices and ideologies of mathematical communities. According to van Oers (2002), it is through the mathematical 'attitude' displayed by community members, for example, classroom teachers and university academics, that aspiring new members of the community, for example, prospective teachers and early career academics, are afforded or constrained in becoming autonomous, critical, and authentic participants in the practice of the community. Attitude as defined here refers to the personal stance manifested by an individual participating in discourse (van Oers, 2002). When this attitude is in accord with a socially accepted genre of mathematical discourse the individual may be said to be employing the 'voice of mathematics'. Bakhtin's (1986) notion of 'voice' provides a mechanism for situating the personal and the social within a particular 'community of practice'. For us (see Renshaw & Brown, 2007), meaning making is simultaneously developed dialectically in accord with Vygotsky's (1987) 'general genetic law of cultural development', and dialogically in accord with Bakhtin's (1986) theory of language. To develop deep understanding of a cultural knowledge, such as mathematics, individuals necessarily have to adopt different voices when speaking within a community of practice and when speaking to different audiences. This continuous dialogical interplay between speakers and audience where ideas and viewpoints are proposed by members of the community allows for the notion of 'voice' to be seen as being compatible with the sociocultural approach used in this paper.

Method

The first research community of practice that is the focus of this article was formed within a larger research project designed to examine classroom teachers appropriation of a theoretically informed and research based pedagogy (Collective Argumentation) for teaching mathematics in the middle years of schooling (Years 6 to 9). Collective Argumentation (Brown & Renshaw, 2000) is a sociocultural approach to teaching and learning mathematics that presents students with mathematics tasks that require them to individually represent a solution, compare, explain and justify this solution within a small group of peers and then come to an agreement with this group on a solution to the task that the group can present to the broader class of students and the teacher for discussion and validation.

The large research project employed a sociocultural methodology, based on a 'design-experiment' (see Schoenfeld, 2006). Professional development sessions were used to assist classroom teachers and university academics to reflect upon and assess the nature of their activity as teachers of mathematics. Each session, based upon what van Huizen, van Oers, and Wubbels (2005, p. 273) refer to as the "basic principles of a Vygotskian paradigm for teacher education" oriented participants towards 'ideal forms' of teaching mathematics using the principles of Collective Argumentation. Each session provided opportunities for participants to learn through providing reports of their own

classroom practice and through interacting in discussions about each other's performance in the mathematics classroom.

The second research community of practice is an international group of mathematics education researchers comprised of university academics and classroom teachers who meet annually to present and discuss refereed research papers, to view and discuss posters of works in progress, and to engage in symposia about mathematics education.

The classroom teacher, Sam, who is the focus of this article, is an experienced teacher of mathematics in the middle (students ranging in age from 11 to 14 years of age) and senior phases of schooling (students ranging in age from 15 to 18 years of age) and a long-term member of both research communities of practice. *The university academic*, Ray, an author of this article, is a mathematics educator in a large metropolitan university and a long-term member of both research communities. (For an elaboration of Ray's mathematics teaching journey see Brown, 2009).

The corpus of data that is the focus for reflection in this paper comprises two data sets. The first set of data relates to a professional development session (the 8th of 12) held towards the end of the second year of the large study. The session, attended by seven classroom teachers and three university academics, focused on inviting teachers to report on the teaching and learning of mathematics in their classrooms. During this session Sam provided a 20 minute report on a mathematics activity that took place in his Year 6 classroom (see Figure 1).

The second set of data relates to an interview Sam provided in the last year of the study whilst he was attending an international mathematics education conference. This interview was conducted by a Research Assistant after Sam had presented a refereed paper (co-authored by Sam and another classroom teacher). The format of the interview comprised 22 open type questions designed to elicit Sam's perceptions of the four interrelated components of knowing and doing within a community of practice as elaborated by Wenger (1998) - 'meaning', 'practice', 'community', and 'identity'.

Analysis and discussion

Sam's report to teachers and university academics

Sam's report focused on the activity reproduced in Figure 1. In the analysis that follows, italics have been used to identify Sam's and others' actual words.

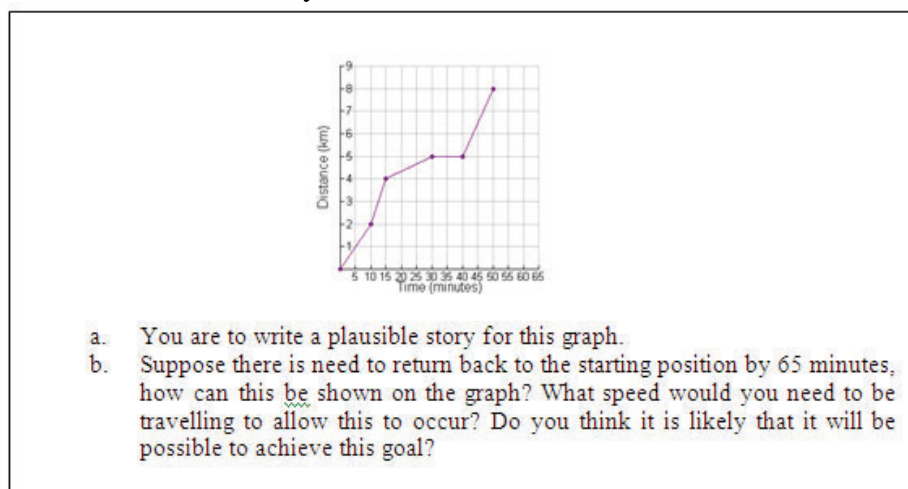


Figure 1: Task sheet as presented to a Year 6 class.

In describing the lesson to teachers and university academics, Sam commenced by situating the activity of this class of Year 6 students within a problem-solving context that allowed students to “*give me some information about how they are going in developing ... understanding*”. Adapting a textbook activity so that it “*allowed them to use collective argumentation*” and so that the students could go “*away and have a bit of a play*”, Sam’s purpose in the lesson was about eliciting “*a variety of responses*” from students.

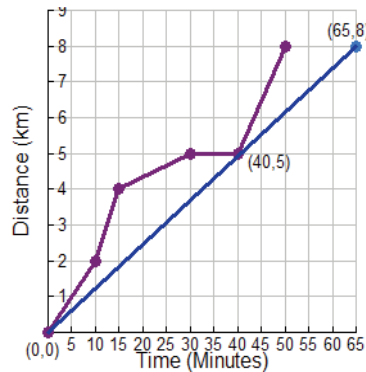


Figure 2: A novel response to a ‘straightforward’ task.

According to Sam, this group of students had translated the problem in terms of the concept of ‘speed’, a translation that Sam considered to be “*pretty cool*”. However, what was “*really cool*” was the return journey where the students “*found the average speed. So they said I want to get home in sixty-five minutes, so this is where home is* [see Figure 2 (0,0)], *so what they found was they drew a point from here* [see Figure 2 (65,8)] *to here* [see Figure 2 (0,0)], *because this* [points to the coordinates (65,8)] *is how far out they are, so they are eight kilometres away and they want to get back home in sixty-five minutes... So that’s the speed he’s got to travel to get back home, and they (the group) found the equation to that particular line.*” Sam then went on to say that he had “*never actually thought about it (the task) like that*” and that “*for them (the group) to interpret it (the task) that way, it’s really cool*”.

Sam’s peers (Julie and Jay) then engage him in discussion about this group response to the task. As the discussion progresses and the teachers struggle to understand this group’s interpretation of the task, it becomes clear that these teachers have adopted a stance within the discourse that privileges thinking about and understanding the mathematics generated by students. The verbal interactions between Julie, Jay and Sam evidence an ‘attitude’ directed toward using students’ representations of solutions to tasks as ‘cultural tools’, that is, as thinking devices that may explain and generate understanding. This ‘attitude’ is given voice by Jay when she states that the student solution “*is a realistic way*” of addressing the task, by Julie when she states that even though “*...we always do it (read graphs) left to right...*”, the group response “*is right*”, and by Sam’s statement that “*...in terms of what I expected (the students to do) and what I got, I thought that (the group response) was pretty cool*”. By adopting this stance, these teachers, whilst struggling to interpret this novel group response within the conventions used for reading graphic representations, are, at the same time, gaining insights into their own practices as teachers of mathematics. However, this stance does not appear to be the one adopted in the discussion by the university academic, Ray.

During the discussion, Ray questions the novelty of the student response by stating that the solution posed seems a “*pretty natural (everyday) thing to do*” and by questioning whether Sam is “*reading too much*” into the thinking behind this response to the task. This questioning is challenged by Sam who states that a “*natural (conventional) solution to the task would be to drop a line from the point (See Figure 2 [50,8]) to the point (See Figure 2 [65,0])*”. Later in the discussion, Ray calls into question the sophistication of the student response by implying that an alternate response to the task that interprets the question as requiring the bicycle trip to be completed from beginning to end in 65 minutes is more sophisticated than the novel group response being discussed where the students have interpreted the task as requiring the home leg of the bicycle trip to take 65 minutes. However, this questioning is challenged by Julie who implies that an unusual response like the group response is “*more interesting*”, therefore more sophisticated, than a “*normal (conventional) response*” to the task.

These interactions with the university academic provide some evidence of what is being valued in the discussion of Sam’s report. For the teachers, privileging thinking about and understanding the mathematics generated by the students seems vital to the teaching learning process. For the university academic, privileging more conventional interpretations of mathematics tasks over student interpretations seems paramount. For the teachers, valuing the “realistic”, the “cool”, the “reinterpreted”, the “unusual”, and the “interesting”, is highlighted in the discussion of Sam’s report. For the university academic, valuing not “reading too much” into a solution, the “sophisticated” and the conventional is highlighted.

According to the teachers, as expressed in their statements during this discussion, student presentations are not just about the representation of correct answers, but about using representations to enhance meaning. That is, using mathematical representations to (a) show a “realistic” way of solving a task (Jay and Sam), (b) “reinterpret” a task construct such as time (Julie), and to (c) show a solution to a task so that others could “understand what their interpretation was and why they did it” (Sam). This view of the function of student representations is in line with Schoenfeld’s (1988) expanded notion of mathematics instruction. According to Schoenfeld, teachers may assist students to think mathematically by using appropriate mathematical notations to make conceptual connections explicit and by applying formal mathematical knowledge to problem situations in a flexible and meaningful manner. As such, it may be said that within the discussion of Sam’s report, Sam, Jay and Julie have adopted a stance which privileges thinking mathematically and that they are giving voice to an expectation that teachers need to engage in thinking mathematically with the class during mathematics lessons. However, in the same discussion, the university academic seems to be privileging ‘mastery’ as he focuses on whether the group of students have mastered the conventions associated with representing information graphically and with due regard to the authority voiced in the problem text. This voice is displayed by the university academic when he poses the question to Sam - “*So are you reading too much into this?*” This utterance places the university academic in the position of the evaluator of Sam’s contribution to the discussion. We can assume from Julie’s statements, where she focuses on the convention of reading graphical representations from left to right and questions “*why they (the group) are going that way (right to left)*”, that the university academic’s statements are a signal to the teachers that Sam’s interpretation of the

student response is now ‘old’ information and that the discussion is now ready for ‘new’ perspectives on the group’s solution to be expressed. However, during the discussion of the report, Jay, Sam and Julie assert and maintain control of the discussion stating that the group solution is a “different interpretation”, “pretty cool”, and “interesting” and position the role of expertise firmly within the teachers participating in the discussion.

According to Wenger (1998), privileging a practice such as ‘thinking mathematically’ within a communal context requires privileging the ability to create new meanings. In turn, privileging this ability entails relations of power, in other words, what legitimacy and efficacy does an interpretation of a task have to ourselves and to others within a community of practice. Communities of practice are important sites for the legitimisation of meaning because they define socially accepted ways of knowing and doing (Wenger, 1998). From the analysis of the text of the discussion that accompanied Sam’s report of his own practice, it appears that the university academic is a legitimate, but ‘peripheral participant’ (Lave & Wenger, 1991) in this discussion, despite his attempts to identify himself with classroom teachers when he states “*Alright now just explain to an ... old primary school teacher ...*” why the group response being discussed was ‘cool’. The interactions between the statements of the university academic and those of the teachers imply that the teacher participants in this discussion view the classroom teaching and learning of mathematics as being their domain of expertise.

This positioning of ‘power’ within this research community of practice raises what Sullivan (2006, p. 307) refers to as interesting “complexities” in the teaching of mathematics. For the university academic it seems important that an alternative solution to the task that interprets 65 minutes as being the total time from the beginning to the end of the bike ride, be a preferred response. Yet Sam, Jay, and Julie have privileged a response that may or may not be acceptable depending on a person’s point of view. The nature of this complexity is, perhaps, given voice in the silence of the other four teachers and university academics present during this discussion. However, for the university academic who did contribute to the discussion, the complexity arises from the tension between his commitment to ensuring that the voices that are privileged within the community are organised around criteria that promote systematic, critical and non-contradictory inquiry and his commitment to valuing Sam’s reported ‘enacted instruction’ practices (Herbel-Eisenmann, Lubienski, & Id-Deen, 2006). The nature of the factors that shape Sam’s practice is evidence in an interview conducted after his presentation of a paper about his classroom practice to delegates at a mathematics education research conference. Due to the focus of this paper only those responses that refer to Sam’s identity are referred to in the analysis below.

Sam’s interview at a mathematics education research conference

In response to the question “What role do you think researchers play in the way you teach in your classroom?” Sam made it clear that he values research with references to using “*Teaching for Understanding*” (Perkins, 1992), “*Collective Argumentation*”, “*mathematical modelling*” and “*technology*” when teaching mathematics. However, Sam also made it clear that the value of research lies in its provision of tools to teachers so that they may assist students to “*build understanding*”. For Sam this utilitarian relationship between classroom teaching and research is given voice when he referred to

teachers giving theoretical ideas about the teaching of mathematics “*a go*” to see if “*they fit*” or “*they don’t fit*” with your “*own way of doing things*”. However when asked about the relationship between classroom teachers and university academics the stance adopted by Sam in his response was very much based on the insider-outsider distinction (Smith, Blake, Curwen, Dodds, Easton, McNally, Swierczek, & Walker, 2009). To Sam, university academics are peripheral participants in the community of classroom teachers of mathematics, participants who enter classrooms to “*look*”, “*probe*” and to “*try some things to see if they make a difference*”, but then “*go away*” leaving the teacher to appropriate what they will from the encounter. In the end, Sam voices the conclusion that university academics “*can’t necessarily have a big impact on a school or on groups of kids or on teachers because you are always looking in ...*”. This “*looking in*” is problematic for Sam because it is sometimes conducted by people who are too far removed from the classroom, who sometimes “*really don’t know what*” teaching mathematics in the classroom is like, who “*dabble here*” and “*dabble there*” and who do not effectively communicate to teachers the findings of their research – “*...what happens in between? Who knows?*” Throughout the interview, Sam adopts the stance that classroom teachers are in an “*interesting place*” because they can “*have more of an impact on what can happen in the classroom*”.

Conclusions

The above analyses provides interesting insights into the notion of teacher identity as a teacher of mathematics and a university academic participate in different communities of practice – a local research community of practice composed mainly of classroom teachers and a more global research community of practice composed mainly of university academics. Through the implementation of pedagogical approaches such as Collective Argumentation, Sam allowed students to make their thinking visible. Representations of student thinking were used by Sam in his classroom as a catalyst to compare, to explain and to develop the mathematical understandings of students. In Sam’s communities of practice (the local and the more global) representations of student thinking were used to model his teaching of mathematics so that others (teachers and university academics) could explore his teaching in order to consider its effectiveness in developing student understanding. As such, the voice of Sam acting in his research communities of practice is imbued with the meanings, intentions, and accents of mathematics lessons that he has taught and is presently teaching in his local school environment. In this sense, the ways in which meaning is represented, explained and developed, between the communities of practice (the local community focused on professional development and the more global focused on research) is, for Sam, ‘critically aligned’ (Jaworski, 2006) to his classroom practice.

Within this alignment, difference is privileged and seen as ‘interesting’, ‘novel’ and as contributing to the understanding and development of mathematics. Hence, an essential insight gained from this research is that learning about the teaching of mathematics occurs most productively when the professional audience is diverse and includes both local community members of teachers and others, such as university academics, whose taken for granted perspectives suggest novel ways of ‘seeing’ and interpreting the local practices. In this way, theories of teaching and learning, for example Collective Argumentation, may inform and become interwoven with teachers’

everyday classroom practice and teacher education may be presented to teachers as a 'process of becoming' (Wenger, 1998).

Sam's 'process of becoming' as evidenced in the above analyses is of interest in itself as it foregrounds a dialectical tension between his classroom community of practice and the more global mathematics education research community as represented by university academics. The research interests of mathematics university academics are concerned with developing and communicating principled, theory based pedagogies that are well researched and evidenced based. However, this is not the central concern of Sam who draws upon a wide range of approaches to teaching mathematics and tries them out for what they are worth to him as a teacher of mathematics. It is as if Sam is saying that, as a teacher I use various approaches to teaching mathematics and am not constrained by the preoccupations of university academics, so the notion of an 'ideal form' of teaching mathematics seems less important to him.

However, improving student understanding of mathematics, as his report and interview responses attest, is important to him. He, himself, is a researcher who has presented evidence of the effectiveness of his practice to an audience of researchers; however, he remains committed to a local community of research practice. As such, there is a dialectical tension within the 'attitude', within the mathematical voice, Sam displays within his interview, a tension that portrays future zones of proximal development that university academics may negotiate with Sam and others so that talk about the practice of teaching mathematics and how to improve it may become accessible to those beyond the local district. What these future zones of contact may be and where they may be negotiated provides fertile ground for further study.

In turn, Ray, the university academic's process of becoming is of interest. The complexity of providing teachers with opportunities to report on and discuss their own practice of teaching mathematics in the classroom, and, at the same time, provide opportunities for teachers to use the products of research to systematically guide the development of classroom practice and to critically look at its effectiveness, needs to be coped with. Too much emphasis on the former may result in teachers adopting an 'ad hoc' accumulation of 'things that fit' with their ways of teaching mathematics, too much emphasis on the latter may reduce teacher participation in a local research community of practice. Perhaps achieving this balance lies within the provision of opportunities to classroom teachers to discuss and compare their classroom practice with 'ideal' forms as practiced and modelled by university academics in their teaching of mathematics. This tension between the 'ideal' (evidenced based approaches to teaching mathematics) and the more local, contextualised approaches to teaching is necessary to the development of a competence that may extend the local research community of practice beyond its borders (Wenger, 1998).

A second important insight gained from this research is that university academics and teachers need to work collaboratively to build on each other's understanding and to develop knowledge networks that encompass more global educational communities of teachers and university academics. In this way, teachers and academics may encounter a diversity of practices and a diversity of audiences that lead to productive tensions and new insights. As such, the relationship between the teachers and university academics in these communities of practice needs to be reciprocal in nature, a relationship not based

on replacing one practice with another but on interweaving (Renshaw & Brown, 2007) classroom practice with the practice and products of research.

References

- Bakhtin, M. M. (1986). *Speech genres and other late essays* (V. W. McGee, Trans.). Austin: University of Texas Press.
- Brown, J. S., & Duguid, P. (2000). *The social life of information*. Cambridge, MA: Harvard Business School Press.
- Brown, R., (2009). Teaching for social justice: exploring the development of student agency through participation in the literacy practices of a mathematics classroom. *Journal of Mathematics Teacher Education*, 12(3), 171–185.
- Brown, R.A.J., & Renshaw, P.D. (2000). Collective argumentation: A sociocultural approach to reframing classroom teaching and learning. In H. Cowie and G. van der Aalsvoort (Eds.), *Social interaction in learning and instruction: The meaning of discourse for the construction of knowledge* (pp. 52–66). Amsterdam: Pergamon Press.
- Herbel-Eisenmann, B. A., Lubienski, S. T., & Id-Deen L. (2006). Reconsidering the study of mathematics instructional practices: The importance of curricular context in understanding local and global teacher change. *Journal of Mathematics Teacher Education*, 9, 313–345.
- Jaworski, B. (2006). Theory and practice in mathematics teaching development: Critical inquiry as a mode of learning in teaching. *Journal of Mathematics Teacher Education*, 9, 187–211.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Perkins, D.N. (1992). *Smart schools: Better thinking and learning for every child*. New York: Free Press.
- Renshaw, P., & Brown, R. (2007). Formats of classroom talk for integrating everyday and scientific discourse: Replacement, interweaving, contextual privileging and pastiche. *Language and Education*, 21(6), 531–549.
- Schoenfeld, A. H. (1988). When good teaching leads to bad results: The disasters of “well-taught” mathematics courses. *Educational Psychologist*, 23(2), 145–166.
- Schoenfeld, A. H. (2006). Design experiments. In P. B. Elmore, G. Camilli, & J. Green (Eds.), *Handbook of Complementary Methods in Education Research* (pp. 193–206). Washington, DC & Mahwah, NJ: American Educational Research Association and Lawrence Erlbaum Associates.
- Smith, C., Blake, A., Curwen, K., Dodds, D., Easton, L., McNally, J., Swierczek, P., & Walker, L. (2009). Teachers as researchers in a major research project: Experience of input and output. *Teaching and Teacher Education*, 25(7), 959–965.
- Sullivan, P. (2006). Dichotomies, dilemmas, and ambiguity: coping with complexity. *Journal of Mathematics Teacher Education* 9, 307–311.
- van Huizen, P., van Oers, B., & Wubbels, T. (2005) A Vygotskian perspective on teacher education. *Journal of Curriculum Studies*, 37(3), 267–290.
- van Oers, B. (2002). Educational forms of initiation in mathematical culture. *Educational Studies in Mathematics*, 46, 59–85.
- Vygotsky, L (1987). Thinking and speech. In R.W. Rieber & A S Carton (Eds.), *The collected works of L.S. Vygotsky, Volume1: Problems of general psychology*. New York: Plenum Press.
- Wegerif, R. (2008). Dialogic or dialectic? The significance of ontological assumptions in research on educational dialogue. *British Education Research Journal* 34(3), 347–361.
- Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. Cambridge: Cambridge University Press.