Robertson, S.-A. (2015). Seeking synergy: The need for research at the literacy/numeracy interface. In D. Huillet (Ed.), 23rd Annual Meeting of the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE): Mathematics, Science and Technology Education for Empowerment and Equity (pp. 185–196). Maputo, Mozambique: SAARMSTE.

Seeking synergy: The need for research at the literacy/ numeracy interface

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This paper emerges from a broader longitudinal case study researching teachers' use of classroom talk in supporting children's numeracy development. This paper argues for the importance, particularly within the South African context, of drawing together theoretical perspectives and insights from language/literacy research and numeracy research. This argument is based on preliminary analyses of: the results of the South African Annual National Assessments [ANAs] (part of the Foundations for Learning campaign); aspects of the post-Apartheid South African curriculum revisions and their attempted implementation; and initial empirical data from the case study teachers pointing to the interrelationship between language and mathematics learning. I propose the merging of three theoretical constructs (from Vygotsky, Halliday and Bernstein) as particularly useful for researching the interface of language and mathematical learning in the first year of the intermediate phase (Grade 4), when the majority of South Africa's learners switch from learning mathematics in their mother tongue to learning in English.

Introduction

A central purpose of education involves helping children move along the 'mode continuum' (Gibbons, 2003, after Halliday) from common-sense ways of thinking and talking about things towards more formalised ways of doing so. Gibbons observes that "children have to learn to use language for a range of purposes and in a range of cultural and situational contexts" (2003, p. 250).

This paper is part of a broader study focusing on the ways Grade 4 mathematics teachers use classroom talk to support learners' linguistic and conceptual development, especially with regard to the way they help learners move from what Vygotsky (2012) termed 'everyday' and 'spontaneous' concepts towards the more 'academic', 'abstract', 'scientific' mathematical concepts that preponderate as children move up through the grades.

The study brings together insights from the teaching and learning of numeracy and literacy to explore the use of talk as a mediational tool in two English second language Grade 4 mathematics classrooms in the Eastern Cape Province of South Africa. Although it is the home language [HL] for less than 10% of the South African population (Statistics SA, 2012, p. 22), English is the prime language of learning and teaching [LoLT]. Language is a major source of frustration and a significant contributory factor to the inequalities plaguing South Africa's primary education landscape (Fleisch, 2008), not least in terms of its impact on epistemological access to mathematics (Setati Phakeng, 2014).

This paper contributes mainly at the conceptual and theoretical level, but some empirical data are used to illuminate aspects of the discussion. I argue from my background in second language teaching and learning that there is much synergistic potential in using insights from

language and literacy research to work at the literacy/numeracy interface. I argue that based on our ANA results for mathematics and language over the past three years, and particularly noting how the 'crisis' (after Fleisch, 2008) is most keenly felt in our less advantaged schools, that the data point to a need to consider this interface more closely. I conclude by arguing for the drawing together of strands taken from three areas of theoretical construct: Vygotsky's socio-cultural theory of learning (2012); aspects of Halliday's systemic functional linguistics view of language as a social semiotic resource (1985); and Bernstein's work on 'pedagogic discourse', and his ideas around the different speech codes children bring to school (1990).

Research design for the broader study

Much research has focused on the contribution of classroom talk to learners' sense-making of ideas and concepts, and on appropriate strategies for analysing classroom talk (amongst others, Mercer, 2004; Barnes, 2008). There has also been extensive research on the place of language in teaching and learning mathematics (amongst others, Adler, 1998; Moschkovich, 2007; Setati, Chitera & Essian, 2009). I have not found much research explicitly focussed on language at the literacy/numeracy interface. Hoadley has worked in this area (2007; 2012), drawing mainly on Bernstein's ideas, and – to a lesser extent – on Vygotsky. The contents pages of the *South African Journal of Childhood Education* reveal relatively little local research work at this interface.

The present study identifies opportunities for cross-pollination between what research has helped us learn about ways for developing learners' literacy (particularly in contexts where this is occurring through a second language), and research into optimal ways of supporting learners' numeracy development. Pursuit of this goal involves examination of the ways two case study teachers use talk (primarily in English) to mediate their Grade 4 learners' numeracy development.

A case study within a mainly qualitative and interpretive paradigm (Patton, 1990) was seen as the most appropriate approach for this research, the case being classroom talk across the two sites. An interpretive view holds that participants in any social context act according to the meanings they ascribe to that context: "social action can only be understood by interpreting the meanings and motives on which it is based" (Haralambos, Holborn & Heald, 2000, p. 971). At the same time, the present study acknowledges the problematic nature of a view of 'reality' as being primarily socially constructed (Maxwell, 2012), and recognises the need to take account of very real external factors impinging upon the research context. (These include management structures; language policy issues; and aspects of South Africa's broader socio-political history and socio-economic patterning.)

The research sites represent what Graven identified as 'opportunity samples' (personal communication, March 11, 2014). The Grade 4 Mathematics teachers at both schools are participants in the Rhodes University South African Numeracy Chair's [SANC] NICLE project [Numeracy Inquiry Community of Leader Educators]: a programme targeting the needs and interests of primary school mathematics teachers. My own membership of NICLE affords me the opportunity of engaging with the two teachers in a co-learning capacity.

Theoretical assumptions about language and learning

Vygotsky proposed a close "reciprocal" / "interfunctional" relation between thought and language (Kozulin, in Vygotsky, 2013, p. xlvii), as well as an essential relationship between talking and thinking. He was also amongst the first to highlight the importance of cultural experience, hypothesizing on the central role played by cultural symbols (*inter alia* language,

books, pictures and other man-made objects) in a child's cognitive development. He argued that these symbols not only affect the *content* of a child's learning, but more importantly, the actual *process* of learning: "When the child learns a language, for example, he does not simply discover labels to describe and remember significant objects or features of his social and physical environment but ways of *construing* and *constructing* the world" (Wood 1998, p. 17). This 'construing' and 'constructing' process, Vygotsky argued, is most powerfully achieved in the zone of proximal development [ZPD] where "a child's empirically rich but disorganised spontaneous concepts "meet" the systematicity and logic of adult reasoning" (Kozulin, in Vygotsky, 2013, p. l). For Vygotsky, children's spontaneous concepts provide "the necessary, *but not sufficient* [my emphasis], conditions for progress toward more powerful forms of thinking" (Renshaw & Brown, 2007, p. 533).

Based on his work on the different speech patterns (language codes) across the social classes in Britain, Bernstein (1964) argued that language was one of the central obstacles facing working-class learners: difficulty in fully understanding and using the elaborated code of speech found in most classroom contexts prevents them from fully accessing the types of abstract thinking that prevail in classrooms. "Aas a child progresses through a school," Bernstein argued, "it becomes critical for him to possess, or at least be oriented toward, an elaborated code if he is to succeed" (1964, p. 67). Countless researchers have used Bernstein in their classroom analyses, including local research by, amongst others, Hoadley and Muller (2009). Throughout his life, Bernstein expended considerable mental energy on unpacking "the inner logic of pedagogic discourse and its practices" (2000, p. 4), and the ways in which these are communicated, and continue to contribute to differences in educational attainment across social strata. Hasan put Bernstein's ideas to the test in Australia, analysing how working-class and middle-class mothers' ways of interacting verbally with their children contributed to their children's 'mental dispositions' (2002). Her findings corroborated those of Bernstein, though she did draw attention to an important point, made by Bernstein himself, which many overlook. This was that, while the mental dispositions children develop in the home undoubtedly impact on the ways in which they subsequently relate to school knowledge, it is not *inevitable* that such forms of consciousness are fixed. New speech encounters in new environments may well lead to the appropriation of new speech systems (linguistic codes), more closely aligned to the "specialised discourses of the school" (2002, p. 17). South African research (e.g. Hoadley, 2006, 2007, and 2012; Hoadley & Muller, 2009) makes similar claims.

Writing about Halliday's contributions to our understanding of how language works as a semiotic system, Foley (1991) explains that Halliday saw a child's progress towards recognising and then realising the full meaning-making potential of language as being achieved through learning from more competent others, and that this "tutelage" constitutes "a vicarious form of consciousness" (p. 24). The parallels here with Vygotsky's ZPD ideas are clear. The significance of Halliday's systemic functional approach to analysing language is that it alerts us to "differences of orientation to meaning and acting" (Foley, 1991, p. 27) which, if linked to Bernstein's ideas around the effects of early socialization on children's speech patterns, helps in our analyses of classroom talk and of the ways it enables or constrains learners' mathematical sense-making.

Some analysis of the interface between language and mathematics in the South African context

Notwithstanding South Africa's post-Apartheid Government's commitment to social transformation via increased educational equity, analyses such as those done by Fleisch

(2008) and Spaull (2013) show we are a long way from realising this. The most recent ANA results (Department of Basic Education [DBE], 2013) reveal a widening achievement gap across the different school quintiles (school catchment areas, based on socio-economic status [SES]), with learners' numeracy and literacy achievements well below what might be expected relative to the considerable investment – in both financial and human terms – made towards improving learners' educational circumstances and outcomes.

The DBE instituted its ANA strategy in 2011.This involves standardised nation-wide testing of all learners in Grades 1-6 and 9. Tables 1 and 2 show some ANA outcomes for Mathematics and Language respectively across 2011-2013.

Table 1: Average % marks in Mathematics by grade (2011-2013)

Phase/ Grade		2011	2012	2013	2011-2013	
					Grade Average	Phase Average
Foundation Phase [FP]	1	63	68	60	63,6	
	2	55	57	59	57	53,6
	3	28	41	53	40,6	
Intermediate Phase [IP]	4	28	37	37	34	
	5	28	30	33	30,3	32,1
	6	30	27	39	32	
Senior Phase [SP]	9	n/a	13	14	-	-

(Data derived from DBE, 2012; 2013)

Table 2: Average % marks in Language by grade (2011-2013)

Phase/ Grade		2011	2012		2013		2012-2013			
							Average		Phase Average	
		Language	HL	FAL	HL	FAL	HL	FAL	HL	FAL
FP	1	59	58	-	60	-	59	-	55,5	-
	2	52	55	-	57	-	56	-		
	3	35	52	-	51	-	51,5	-		
IP	4	34	43	34	49	39	46	36,5	46,6	37
	5	28	40	30	46	37	43	33,5		
	6	28	43	36	59	46	51	41		
SP	9	n/a	43	35	43	33	43	34	-	-

(Data derived from DBE, 2012; 2013)

The data here show the marked fall off in children's numeracy and literacy performance as they proceed up the grades. The fall off between foundation and intermediate phase average marks across the three years is notably steeper for mathematics (53,6% down to 32,1%) than for language (55,5% down to 46,6%); a range differential of 21,5% and 8,9% respectively. This differential may in part be a consequence of children having to contend with a double load: more challenging and abstract mathematical tasks, coupled with less scaffolding of the vocabulary and syntactic structure of the language in these tasks. This latter point is currently being investigated by Sibanda (2013). Such a fall off is not uniquely South African, however. American research, for instance, revealed that most children progress through the earlier stages of reading development in similar ways, but once the controlled and scaffolded reading typically found in the early grades gives way to texts "more varied, complex, and challenging linguistically and cognitively" (Chall & Jacobs, 2003, unpaged), unevenness in children's

achievements appears. Increased text complexity is often accompanied by expansion in the number of subject areas making up a curriculum. Encounters with new knowledge areas and a less highly controlled vocabulary and syntactic load places considerable strain on learners. Chall and Jacobs labelled this fall off the 'fourth-grade slump', noting that such slump is more prevalent amongst children of lower SES (2003).

Innumerable studies have attested to a quite intractable correlation between low SES and low educational attainment (amongst others, Pretorius & Naude, 2002; Hart & Risley, 2003). In his analysis of the crisis in South Africa's primary school education, Fleisch (2008) drew attention to a marked 'bimodal distribution' of achievement in literacy and numeracy across the different socio-economic and racial sectors of our society. More recently, Graven (2014) noted that South Africa "provides an 'extreme' case of performance gaps between high and low SES learners even while political will and resource allocation for redressing inequality are identified as a national priority" (unpaged). The following table shows some poverty-related achievement differentials in the 2013 ANA results.

Table 3: Average % ANA marks in Language (Home Language [HL] & First Additional Language [FAL]) and Mathematics by grade and quintile [Q] (2013)

Phase/ Grade		LANGUAGE						MATHEMATICS		
		HL		Range	FAL		Range			Range
		Q1	Q5		Q1	Q5		Q1	Q5	
FP	1	57,6	75,7	18,1	-	-	-	56,6	68,6	12
	2	52,4	70,6	18,2	-	-	-	55,5	70,6	15,1
	3	48,5	59,8	11,3	-	-	-	49,6	66,6	17
IP	4	40,9	61,7	20,8	36,7	54,8	18,1	31.8	52,9	21,1
	5	35,2	63,8	28,6	33,5	59,5	26	28,7	50,8	22,1
	6	46,6	70,5	23,9	43,3	59,2	15,9	34,6	54,3	19,7
SP	9	32	54,6	22,6	30,4	47,5	17,1	11,7	26,7	15

(Data derived from DBE, 2013)

The data on range across Q1 and Q5 show how markedly the equity gap widens up the grades. Consistent with earlier comments regarding the 'fourth-grade slump', overall the equity gaps are larger in IP than FP. The Grade 4 mathematics classrooms in the present study serve children from lower down South Africa's SES ladder, and any disadvantages deriving from this circumstance are almost certainly compounded by the schools' LoLT decisions.

Some analysis around the LoLT issue

The percentage of South Africa's learners learning through their HL is low. In both research sites, although the HL of teachers and learners alike is isiXhosa, the LoLT is English, putting these learners amongst the 79,1% of South African Grade 4s using English as LoLT (DBE, 2010, pp. 13; 16). Motala and Dieltiens (2011, p. 11) note that South Africa's 1997 Language in Education Policy "tends in practice to privilege English (and Afrikaans), despite a rhetoric of equality regarding the other nine official languages." Figures in Table 4 highlight the scale of this privileging of English.

Table 4: Percentage of learners using English as LoLT (Grades 1-12) (2007)

Grade	1	2	3	4	5	6	7	8	9	10	11	12
%	21,8	23,8	27,7	79,1	81,1	81.6	80,6	80,9	80	81,2	82	81,4

(Data derived from DBE, 2010, p. 16)

Research evidence shows a good correlation between "mother tongue education and scholastic achievement" (DBE, 2010, p. 5). The figures in Table 4 suggest, however, that such is the power of English that those making decisions about schools' language policies may be turning a blind eye to some of the epistemic implications of an English LoLT whereby learners face the dual challenge of trying to *master* English, while at the same time learning *through* English. Mathematics, too, being a 'language' (Schleppergrell, 2007) simply adds another layer of linguistic and conceptual complexity. Schleppergrell commented that "a key challenge in mathematics teaching is to help students move from everyday, informal ways of construing knowledge into the technical and academic ways that are necessary for disciplinary learning" (2007, p. 140). Writing of her mathematics learning experiences, Setati Phakeng noted that her "greatest difficulty was learning in a language in which I was not fluent," leading, she said, to heavy reliance on rote-learning (Setati Phakeng & Moschkovich, 2013, p. 121).

In terms of the language policies at both research sites, all the Grade 4s, although native speakers of isiXhosa, are - officially - learning mathematics in English. Both teachers acknowledge an element of bilingualism in their teaching. School A's Grade 4s are in their first year of English as LoLT, having had mother tongue LoLT through foundation phase (Grades 1-3). In her initial interview, their teacher remarked: "We must teach them in English here. But I am doing them in both Xhosa and English." Because School B has a straight-for-English policy, the Grade 4s there have had a longer and more extensive exposure to English. At neither school, however, are the Grade 4s yet fully proficient in English. They are thus unable to fully exploit it as a (semiotic) resource for learning. Rather than viewing this circumstance in deficit terms, the present study takes the more positive stance of viewing these children as 'emergent bilinguals' (Garcia & Kleifgen, 2010, p. 2), capable of functioning in their HL while building up their English proficiency.

Analysis of some recent curriculum revisions

South Africa's Curriculum and Assessment Policy Statement [CAPS] describes mathematics as "a language that makes use of symbols and notations to describe numerical, geometric and graphical relationships" (DBE, 2011, p. 8). Amongst the specific mathematical skills that learners need, are the following: "correct use of the language of Mathematics", "number vocabulary", and "the ability to listen, communicate, think, reason logically and apply the mathematical knowledge gained" (DBE, 2011, pp. 8-9). All of these are language dependent, and invite reflection upon Cummins's distinction between BICS (basic interpersonal communication skills) and CALP (cognitive academic language proficiency) (n.d., p. 1). Prior to CAPS, South Africa's NCS specifications for the Languages Learning Area included a learning outcome (LO) explicitly requiring language teachers to attend to aspects of learners' CALP development (Department of Education, 2002), but this appears to have been down-played in CAPS. I refer here to LO5: *Learning and thinking:* use of language to think and reason, and access, process and use information for learning. The diminution of this LO carries the risk that language teachers – however inadvertently – may neglect giving systematic support to the development of aspects of learners' meta-cognition and verbal processing. The ability to understand and use spoken language beyond the BICS level (Cummins, n.d.) is critical for literacy and numeracy development. One other element of diminution worth mentioning is that – paradoxically - in terms of language policy pre-1994, African children may in fact have been marginally better off relative to their preparation for English as LoLT. Pre-1994, in African schools English was introduced as LoLT from Grade 5 (a year later than is currently the case). Most African children would also have learned

English as a subject for three years prior to its becoming the LoLT. Murray (2012) notes that "new policies and curricula have had the effect of delaying the introduction of English as a subject and accelerating its introduction as a LoLT, thus reducing the time to prepare for the transition" (p. 3).

A core goal of South Africa's post-1994 educational reform is to help teachers move away from largely teacher-centred, behaviourist-dominated conceptions of teaching towards more learner-centred constructivist approaches. Sfard (1998) captures this distinction well in her discussion of what she termed the *'acquisition'* and *participation'* metaphors. Whereas the older (acquisition) metaphor conjures up images of "the human mind as a container to be filled with certain materials and about the learner as becoming an owner of these materials", in the newer (participation) metaphor "learning a subject is … conceived of as a process of becoming a member of a certain community" (1998, pp. 5-6). Much remains to be done in helping teachers deepen their understanding of strategies for helping learners become more actively-engaged participants in "working on [their own] understanding" (Barnes, 2008, p. 3).

In relation to mathematics teaching and learning, Lerman (2000) notes how discussion around the absolutism/fallibilism dichotomy led to challenges to "the traditional mathematical pedagogy of transmission of facts" (p. 22), ultimately leading to a 'social turn' whereby ideas about "meaning, thinking, and reasoning" are viewed as much more 'situated' "products of social activity" (p. 23) (as opposed to being seen simply as the outcome of detached, and ostensibly objective logical reasoning). A similar 'turn' has occurred in literacy circles whereby it is recognised that conceptions of what literacy is, of how it is to be used, and of what value is to be placed on it, vary across social contexts. Heath's classic '*Ways with words*' ethnography (1983) illuminates this point well. Her study demonstrated how the different patterns of language socialization children bring into the classroom can profoundly affect their educational attainments (1983, p. 349). The patterns children bring to the classroom may then be echoed in the pedagogical patterns of the classroom. Closer to home, Hoadley (2006) argued that "school and classroom processes potentially amplify differences between students, disadvantaging the working class" (p. 2). In a subsequent paper, focussing more specifically on mathematics pedagogies, she compared the teaching of mathematics in Grade 3 classrooms across the SES spectrum. Her analysis demonstrated how different teaching styles in the different social-class settings gave rise to "differential access to specialized school knowledge" (2007, p. 703). She concluded that children's "potential for acquiring ... the specialized knowledge of mathematics, is seriously undermined in [by] the pedagogy" she observed in lower SES classrooms (2007, p. 704).

Some analysis around the importance of patterns of talk in classrooms

The decision to make talk the focus for the present study was fuelled by the recognition that – as aptly put by Douglas Barnes - "learning floats on a sea of talk" (cited by Simpson, Mercer and Majors, 2010, p. 1). These writers note that there has been a resurgence of interest in the value of classroom talk as a pedagogical device (2010, p. 1). A particular advantage of talk is that, unlike writing, talk "is easy and impermanent. We can *try out an idea and change it* [my emphasis] even as we speak. Exploratory talk ... provides a ready tool for trying out different ways of thinking and understanding" (Barnes, 2010, p. 7).

Graven notes that encouraging children to communicate their mathematical thinking verbally (rather than having them either work things out on paper, or come up to laboriously try out solutions on the chalkboard) is a useful way of maintaining a brisk pace and helping children keep focussed on the task at hand. In many of the classrooms she has visited, however, she has noticed that teachers tend to emphasise listening at the expense of talking, and on

occasions if children asked questions, they were scolded for *not* having listened attentively enough. She thus identifies the raising of primary mathematics teachers' awareness of how crucial it is that children be given opportunities to *engage verbally* as one of NICLE's key priorities. SANC's support for the present study derives from this perception (personal communication, March 12, 2014).

Studies of patterns of talk in the classroom reveal substantial asymmetry in teacher: learner talk. Overwhelmingly, it is teachers who do the talking. This, as Wells notes, is at odds with the pattern of adult-child interactions revealed in his longitudinal study of differences in language at home and at school where, if anything, the asymmetry was in the other direction (1986, p. 86). The predominance of teacher-talk seems a particularly prevalent feature of many South African township schools. Hoadley, for instance, cites Chick's finding of teachers "adopting authoritarian roles and doing most of the talking, with few pupil initiations, and with most of the pupil responses taking the form of group chorusing" (2012, p. 3). Chick's work dates back to 1996; but classroom videos from Year One of the SANC project indicate that such patterns persist (Graven, 2012). It would seem that teacher talk is a deeply ingrained aspect of teachers' *habitus* (after Bourdieu, 1974). Wells, in distinguishing between 'monologic' (teacher talk) and 'dialogic' (teacher/learner talk) classroom interactions, insists that "education requires both" (2007, p. 263). In his exploration of what he termed the 'emerging pedagogy' of the spoken word, Alexander too found monologic talk the prevailing mode, noting that, while "classrooms are places where a great deal of talking goes on, talk which in an effective and sustained way engages children cognitively and scaffolds their understanding is much less common than it should be" (2005, p. 2).

Teachers' language insights in relation to their numeracy teaching

In interviews for the present study, both teachers identified the challenges their learners face with English: mastering it, *plus* having it as the LoLT for their mathematics lessons. School A's language policy parallels that recommended in CAPS (mother tongue education through the foundation phase years, transitioning to English as the main LoLT in Grade 4). Although the current Grade 4 cohort started learning English (as subject) in Grade 2, Teacher A notes her learners' struggle with it: "The English is not easy for them because in their foundation phases they were doing everything in Xhosa-mother tongue. But now in Grade 4, is that transition. Eh! It is not easy." Despite School B's earlier start with English as LoLT, Teacher B said that language remained a challenge. "Because," she explained, "all these learners here at school are Xhosa-speaking learners, and maths is done in English. And maths also has its own language. ... that is a main problem."

Most if not all the children at both schools come from relatively less affluent homes, although Teacher B did indicate that School B's fees are significantly higher than those of other township schools: "Other schools, maybe the school fees are R50 for the whole year. Here I think it's R140,00 per month." School A's learners appear to be especially vulnerable to the many difficulties attendant upon poverty. Unprompted, Teacher A remarked in the initial interview that most of her learners had problems. "Some of these problems," she said, "are social problems. Most of our kids are sick. They're on treatment. So they don't cope most of them."

These remarks from the case study teachers clearly demonstrate the futility of tackling problems of low levels of numeracy achievement independently of attention to language and SES issues, or – indeed – to larger social issues.

Concluding comments

The contribution this paper makes is to provide a rationale for the need for research at the numeracy/literacy interface, and to bring together three socio-cultural and socio-linguistic theories of learning to conduct a triple-layered analysis of mathematics classroom talk in the context of low-SES and L2 teaching/ learning environments. The three theories cohere in that all acknowledge the centrality of language. At the same time each has the potential to provide insights from slightly different perspectives. The brief analysis provided here of the ANA results, curriculum policy, and teacher experiences points to the need for such a triple-layered analysis as a means of exploring synergistic opportunities at the numeracy/ literacy interface.

The two case study sites, being at once sufficiently similar and sufficiently different, together, promise to generate rich insights around the issue of mathematics classroom talk taking place predominantly through non-mother tongue, and in low-SES contexts. While it is seldom the nature of interpretive case studies that they allow for generalization, there is value in looking "carefully at individual cases ... not in the hope of proving anything, but rather in the hope of learning something" (Eysenck, cited by Flyvbjerg, 2006, p. 224). It is my hope that this case study investigation of teachers' use of classroom talk in mathematics lessons may resonate in significant ways with others involved in similar circumstances. Cresswell and Miller (2000, p. 129) note that 'thick description' is one way of helping others assess the extent to which findings resonate with (or 'relate' to) other settings.

Acknowledgements

I thank Professor Mellony Graven for her invaluable guidance on earlier drafts of this paper. This work is supported by the DHET, FirstRand Foundation (with RMB), Anglo American Chairman's fund, the DST and the NRF.

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