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DILEMMAS AND A PARADOX—SECONDARY MATHEMATICS TEACHERS' KNOWLEDGE OF THEIR TEACHING IN MULTILINGUAL CLASSROOMS*

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Abstract—This paper reports on the first stage of a research project that investigates the dynamics of multilingualism and the teaching and learning of mathematics in junior secondary classrooms in South Africa. The paper situates the project theoretically and methodologically and then focusses on an initial set of in-depth interviews with six teachers in three different classroom contexts. The analysis of presences and silences within and across teachers' accounts suggest that teachers in multilingual contexts confront and produce language-related dilemmas and a paradox as they manage their teaching. These, in turn, raise interesting questions for further analysis and research.

> (A) major source of societal influence on the learner's knowledge of mathematical ideas is the language used ... language issues are extremely complex.... If countries ... are to engage in the process of cultural reconstruction, then the language element in relation to informal, non-formal and formal mathematics education is critical. (Bishop, 1993)

South Africa is undoubtedly in a process of both political and cultural reconstruction. Key education policy documents have taken up the critical position of language in education (ANC, 1994; NEPI, 1993). Given the essential relationship between language and learning, and that South Africa is a country of many languages, they advocate *multilingual teaching practices. All* teachers should "regard themselves as teachers of language" and "that they be progressively helped to become more effective in this role" (ANC, 1994, p. 63).

Multilingual teaching policy reflects a commitment to democracy. In addition, a flexible and developmental language policy in the early years of schooling is clearly crucial for young children. It is likely, however, that with its global economic and political currency, English will remain the language of instruction in most secondary schools.

Current teacher education courses do little to prepare teachers for their task of teaching subjects like mathematics in English to learners who are not English-speaking (NEPI, 1993, p. 181). At this juncture of reconstruction and development in South Africa, those of us concerned with teacher preparation and development must ask: What specific language-related teacher education should mathematics teachers have? The answer to this question lies in unravelling, from a pedagogical perspective, the dynamics of multilingualism[1] and the teaching and learning of mathematics.

Current mathematics curriculum initiatives in South Africa have been strongly influenced by both constructivist theory and related curriculum developments internationally.[2] These entail a significant shift away from authoritarian teaching practices and thus must be welcomed. However, the pedagogical approach advocated depends on a language-rich classroom, and communicative competence in learners. I have

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argued elsewhere (Adler, 1992a, 1994) that research in support of these initiatives both here (e.g., Murray et al., 1992) and elsewhere (e.g., Cobb et al., 1991) takes communicative competence for granted. This is alarming, particularly in South Africa where pedagogical practice must impact on and be impacted on by situations where so many are learning mathematics in English and English at the same time.

This paper reports on the first stage of a research project that investigates the dynamics of multilingualism and the teaching and learning of mathematics. In motivating the research, the paper begins with an overview of the field of mathematics education and builds the argument that (a) the dynamics of mathematics learning in multilingual classrooms lies in the interplay between proficiency in the language of learning, access to the mathematics register, and to classroom discourse, and (b) approaching the research through teachers' knowledge is appropriate. It then briefly describes the theoretical and methodological framework of the research. All this informs the discussion of the data and the major thrust of this paper—my description and interpretation of the language-related dilemmas that secondary mathematics teachers in multilingual contexts face as they manage their teaching.

Language and Mathematics Education

Since Austin and Howson's seminal article (1979), the complex inter-relatedness of language, mathematics, and mathematics education has been the object of a great deal of both empirical and theoretical research.

Access to the mathematics register has been the focus of a number of studies, the most extensive and rigorous of which is Pimm's (1987). Drawing on Halliday, he shows that learning to "mean" mathematically (acquire mathematical communicative competence) in school is not only a matter of acquiring the specifics of the mathematics register, but doing so within the peculiar dynamics of mathematics classroom communication. Despite his attention to these dynamics, and as Pimm himself acknowledges, he has not addressed the additional demands in multilingual classrooms (1987, p. 204). And there are additional demands.

Zepp (1989), Durkin and Shire (1991), and Clarkson and Thomas (1993) take up the issue of bilingualism and mathematics learning. Drawing on Cummins' research which distinguishes different levels of bilingualism and shows learning is related to levels of proficiency in both languages, all argue now that bilingualism per se does not impede learning. But the emphasis in these studies is psycholinguistic—they focus on concept acquisition, conceptual structures, and comparative studies of these across speakers of different languages. The dynamics of bilingualism and mathematics in classroom settings, while recognised, appears to not be examined.

This is a shortcoming. Much of what we do in schools is probably framed more by cultural and social practices than cognitive structures. This is now widely acknowledged by mathematics educators (see, e.g., Hoyles, 1992; Bishop, 1993; Ellerton & Clements, 1991) and specifically taken up by Mouseley and Marks (1991). In their brief, sociolinguistic discussion of discourses, genres, and texts in mathematical education, they argue that pedagogical approaches carry all kinds of cultural assumptions which if not made explicit favour some children over others. This links with recent, interesting research which shows how race, class, and gender differences in mathematics performance are produced through discursive practices in mathematics classrooms and texts and thus cannot be accounted for in terms of cognition alone (see, e.g., Walkerdine, 1988; Dowling, 1993). Yet, what is missing is a specific focus on multilingualism as a dimension of difference and possible disadvantage. Crawford's (1990) study of aboriginal learners appears to be one of the few that integrates culturally embedded communicative patterns and functions with access to the (English) mathematics register in an explicit bilingual context. She examines the potential of new educational computer software to change the social organisation in classrooms with Aboriginal students in a positive way "so that language functions to inform students about mathematical contexts". Using a Vygotskian, that is, a cultural–historical, framework and thus that "language is, par excellence, the medium for the social construction of both social and physical realities", she shows that learners who speak a different language from the language of learning are not simply disadvantaged by a lack of proficiency in

the language of learning, but much more by cultural processes entailed in and through language intersecting with the difficulties for all learners with access to the English mathematical register.

In sum, while Ellerton and Clements (1991) correctly argue that the field of language and mathematical education is fragmented, dispersed, and infused with diverse emphases and underpinnings, the account given here suggests that the dynamics of teaching and learning mathematics in multilingual classrooms is not simply about proficiency in the language of learning; nor is it only about access to the (English) mathematics register; nor should it be reduced to social diversity and social relations in the classroom. These three, while analytically separable, are in constant interplay in the cultural processes that constitute school mathematics learning.

Language, Mathematics Education and Teachers

What is remarkable about all the literature reviewed on mathematics and language is that while teachers and teacher educators are the audience to whom most of the texts are addressed, and many say that mathematics teachers are and should be language teachers (Zepp, 1989; Stephens, Waywood, Clarke, & Izard, 1993), none appears to be concerned directly with how teachers themselves make sense of the relationship between mathematics teaching and language. What do teachers understand this relationship to be?

Every day, many teachers in South Africa, and elsewhere, manage their mathematics teaching in multilingual settings. As such, they are confronted by situations that might otherwise be taken for granted, situations constituted by the triple interplay suggested above. Starting with what they have learned and what they prioritise for their pedagogical practice makes good sense.

This is not to suggest that there are no horizons to practical knowledge, nor that it is appropriate to conflate espoused theories with theories in action (Argyris & Schön, 1974), nor that teachers have some generalised decontextualised belief-system (Hoyles, 1992). I have argued elsewhere for activities that enable mathematics teachers to integrate theoretical, practical, and research knowledge and situate this in the contexts of their work (Adler, 1992b, 1993). As Levine (1993) claims, "teachers build theories just as much as theories build teachers".

Lampert's (1986) illumination of how differently primary mathematics teachers and researchers talked about the same educational research problems suggests a value in researching educational problems through teachers' knowledge. Hoyles adds to this by pointing to many discontinuities, inconsistencies, and contradictions in teacher beliefs. Drawing on Secada's argument that work on teaching "needs to include teacher beliefs, knowledge and behaviours **as a function of the sorts of students who are in their classrooms**" (my emphasis) (1991, p. 46–47), Hoyles proposes "beliefs as situated-dialectical constructions, products of activity, context and culture" (1992). And so, again, the value of inquiring into the complexities of teacher knowledge of the dynamics of teaching and learning mathematics in multilingual classrooms.

I have argued here for the value of teachers' knowledge as an appropriate and important source in a study of the dynamics of multilingualism and mathematics teaching and learning. Ultimately, this paper is *my* account, as researcher of that knowledge.

Theoretical Framework

A social theory of mind—that consciousness forms in and through socially mediated activity, with language as a key mediational mean (Vygotsky, 1986, 1978)—informs this study, providing theoretical and conceptual tools to examine both multilingualism and teachers' knowledge of such.

For Vygotsky, what makes speech human is that it has meaning: "To understand another's speech, it is not sufficient to understand his words—we must also understand his thought. But even that is not enough—we must also know its motivation" (1986, p. 253). Hence classroom communication entails more than proficiency in the language of instruction: It requires understanding thought, and intentions and thus cultural processes. In addition, speech, for Vygotsky, has a communicative and intellectual

function (1978, p. 7). It is both tool, functioning externally, and sign, turned inward, and a key mediator in the development of higher psychological systems. What this suggests is that speech in school must impact on mathematical learning, and hence in particular ways in multilingual settings.

Similarly, working with teachers' knowledge, it is not enough to only have what they say. We need also to understand their meanings and intentions. Thus, there is a need to reveal and examine what Argyris and Schön (1974) describe as both their espoused theory and their theory-in-action.

Within a social theory of mind, teachers' knowledge is understood as socially mediated. Thus, what they are able to account and reflect on forms and is formed by their activities and practices which are social (located in institutions of society), cultural (located in language, symbols, and ideas) and have a history. This means that teachers in and from different contexts and settings are likely to have different accounts. Simultaneously, since they share the practice of teaching secondary mathematics, their accounts are likely to contain commonalities. And this assists the argument below for a strategic and small selection of teachers for the study.

Research Methodology and Research Design

> To undertake research which takes account of the diversity amongst teachers, students and mathematics raises enormous methodological problems ... (Hoyles, 1992)

Lerman (1993) provides a thorough account of the difficulties of teacher research in mathematics education. In the move away from product–process research, its positivist assumptions, and decontextualisation of teaching and learning, qualitative studies of teachers have mushroomed.

This study is interpretive (Erickson, 1986) and has used qualitative methods (Smaling, 1990, 1992) to collect teacher accounts. These were:

1. An initial semi-structured, in-depth, interactive interview.
2. A reflection back to teachers interviewed to validate an initial interpretation of the interviews.
3. Up to 3 hours of videotape of at least two consecutive lessons in each teacher's class and reflections on these.
4. A series of workshops on issues and aspects of the data that the teachers themselves wanted to pursue.

Accounts were thus gathered in different contexts and through different activities, not for the traditional purposes of triangulation to arrive at the truth or consistency of what teachers say, but more for ensuring that rich description, multiple perspectives and voices, anomalies, and internal contradictions are made possible.

The Sample

As an in-depth study the sample was *strategic* and *small*. In order to illuminate multiple perspectives, six secondary mathematics teachers, from three differing multilingual contexts were selected, that is, two teachers from each of:

1. Recently desegregated state schools (called *Model C* schools here). English is the dominant language in and around the school, teaching staff remains white and English-speaking, there are increasing numbers of pupils of other languages, and these schools are adequately resourced.
2. *Private* schools, which have predominantly black pupils who are not English-speaking at home. These schools are well-resourced and most teachers are English-speaking. The two private school teachers in this study are both white and English-speaking.
3. Black state Department of Education and Training (*DET*) schools. Here, neither teachers nor pupils are native English-speakers. In addition, they are unlikely to all share the same home language. These schools are poorly resourced, and in the past decade, a learning culture has all but broken down.[3] The black state school teachers in this study are both black and Tswana-speaking.

I further selected teachers with tertiary mathematics qualifications, at least 3 years teaching experience, and who were interested in the study and could thus assist in access to their schools. (The political context often rendered some schools inaccessible to researchers.)

The focus of the paper is the initial interview since the richness of this data warrants its own attention. It both illuminates some of the dynamics of teaching and learning mathematics in multilingual classrooms and provokes interesting questions for further analysis and attention.

The Initial Interview

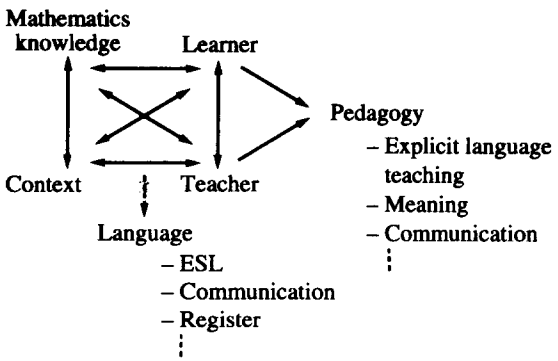
The initial interview was semi-structured, comprising three central questions:

1. Describe the context and ethos of your school.
2. What for you are the general tasks and challenges in teaching junior secondary mathematics in your school?
3. More specifically, what language issues do you face in your mathematics teaching at this level?

The function of the first two questions was to provide a context for interpreting accounts related to the third and the main focus of the study. Together these questions reflect a view of curriculum as relational, that is, as an interaction between task (knowledge), learner, teacher, and context (see below).

Data Interpretation

Each interview generated a great deal of both structured and unstructured data. Broad categories of interpretation were thus constructed from a combination of a relational conception of curriculum (adapted from Christiansen & Walther, 1986, and illustrated below) and Vygotsky's notion of language as mediator. Careful attention, that is, "listening" to the data, in the light of the field of language and mathematics education, assisted the construction of sub-categories, also illustrated below.



With the above category framework it became possible to generate a map (as above) of each interviewee's response categories, and from there the extent and nature of how the teachers differed in the categories they emphasised became apparent. In other words, it became possible to easily attend to presences and silences within and across the six interviews.

In the remainder of this paper I describe, interpret, and interrogate the language-related commonalities, divergences, presences, and silences in the collective account of the teachers interviewed. From my perspective as researcher, these reveal how different contexts and conditions give rise to different dilemmas for teachers as they go about their work.

Description and Interpretation

Commonalities (presence across all teachers)

1. *Communicating in English, the language of instruction.* English is the official language of instruction in all six schools. While more or less intentional, each teacher spoke of learners using their preferred language (i.e., not English) at times. Each teacher also mentioned some occasion where either they had difficulty in explaining through English, or pupils had difficulty in expressing themselves in English.

Without wishing to trivialise any of the above, it makes sense that learners who are not fluent in English will resort at times to their spoken language. Also, when forced to speak English, they will struggle with this. The teachers are aware that the experience of these learners in school is such that at times they are blocked from using verbal speech, and that this must have some effects. In the words of DET 4:

> ... even though they can hear like I said, it would be much better if they could also talk about it in English—they would understand more—they would raise their views on it and it would make it easier to understand. I think, communication is very important in learning maths, and if you can't communicate then it makes it difficult.

And this supports my earlier criticism of recent research in classrooms where *all* pupils are supposedly communicating their mathematical ideas and thinking, yet the research is silent on and thus takes communicative competence across all learners for granted.

2. *Difficulty with the mathematical register.* All teachers are aware that the mathematics register is a problem some of the time. All described

difficulties with specific mathematical language: typically with the way word-problems are expressed, and with algebraic language. For example:

> ... what did I have recently? Oh yes! 2a – a. To me they said: (pointing to the a) "There is nothing here, so the answer is 2a". They see 2a and 0a and so get 2a. (DET 3)

Difficulties with algebraic language are well known, extensively discussed by Pimm (1987) and experienced by many learners, irrespective of their spoken language. MacGregor (1993) has shown specific ESL (English Second Language) difficulties with mathematical expression in English. But as I argued earlier, the issue here is not simply one of "register". It is also about how it can be handled in English, and within school mathematics culture.

Divergences, Dilemmas, and a Paradox (confronting the taken-for-granted)

More interesting than that which was shared are dimensions of language that emerge for *some* of the teachers in their particular multilingual setting as they confront what might otherwise be taken for granted. They are interesting both because they are linked to the context of the teacher's work, to situations of change, and because they reveal dilemmas that teachers face in their practice.

1. *Developing spoken English vs. ensuring mathematical meaning: or, when to use the vernacular*? Both teachers in the DET schools are fully bilingual (English/Tswana). This asset is not shared by the four English-speaking teachers, though one does understand and speak some Zulu. With this bilingualism is always the possibility of explaining in the vernacular and this creates tensions and dilemmas:

> ... in Std 7, where I asked a question and one answered in Tswana. And I said: "Can you please try answer that in English—I don't understand that?" and he said, crossly "No, mam, but you are Tswana—you are not white!" He was angry. But it is not like that in Std 9 ... they like to work in English.

and later in the interview:

> Sometimes you find that you get stuck because students cannot communicate—then, though not much, you resort to Tswana. You are careful because if you do that then they want you to do it all the time, and they turn the situation to a Tswana class. Then they will never improve.

Earlier, this teacher was also quite adamant that she "never translate(s)...". This espoused theory could be related to the strong policy on English enacted in her school by a grouping of teachers she explained as follows:

> We have sort of formed a group. We have said that if there is someone (*a teacher*) who doesn't come to school we confront them, and if you don't appear in class we confront them. If we pass your class and you are teaching in vernac, we confront you. So that is the thing the group adopted.

And linked to the reality that vernacular teaching is not straightforward either:

> ... there are Xhosa speakers in the class—so if I am speaking Tswana then they complain I am favouring them ... (DET 4)

On the other hand, DET 3 acknowledged difficulties teaching in English and explained how some ideas (those easily linked to everyday life) are carried better if explained in Tswana.

> ... at times (teaching in English) is a problem. You feel bad that you don't succeed to reach them, and then this is bad. But it only happens in the lower classes ... with the 10's it is English all the time.

Talking about the 2a – a problem above:

> I say, my girl, bring me that book. Then I say I have two books, and she brought one book. And that, problems like that I go on in English. But there are similar cases like say half plus half, and they have serious difficulties, and then I say, in Sotho: I have a half a loaf, and a half a loaf, how many...?

It is clear from these two accounts that both teachers are in fact engaging in multilingual teaching. Their strategy is to use English themselves most the time. But in the lower classes it is simply not possible to do so all of the time. Somehow (by osmosis?), this "problem" disappears in the upper secondary school. The tension and dilemma is how to develop spoken English without jeopardising mathematical understanding in the lower classes and these emerge because of the particular multilingual setting here: Teachers and many learners share a spoken language but this is not the language of learning.

Thus, policy advocating that there be multilingual teaching is in fact already in practice. Bilingual teachers can and do shift in and out of different languages but face a constant dilemma in the junior secondary school over how

to develop both mathematical meaning and spoken English simultaneously. There is very little in the literature that alerts us to this particular dilemma for bilingual teachers. An obvious question that arises is: Does what teachers SAY actually happen in class? Perhaps more important is that detailed research with teachers into their switching in and out of English could illuminate whether and how such practice facilitates and/or obstructs mathematical learning.

The dilemma of whether to use vernacular *as teacher* is obviously absent in settings where the teacher is monolingual and English-speaking. What speaking strategies emerge as these teachers account for *their* multilingual settings, that is, they are not bilingual, and some or all learners bring to class, spoken languages different from the language of instruction?

These range from (a) being alert to pupil–pupil discussion that occurs in vernacular and asking that this then be explained in English (for the teacher and other learners) (private, 6) to (b) encouraging learners to use whatever language is comfortable as they discuss and develop mathematics ideas with each other (the private space if you like), but that when they report on their thinking to the rest of the class (the public space) this must be done in English (Model C, 1), and (c) repetition—where teacher repeats ideas in English in different ways (private, 5) and where learners are continually asked to repeat words and phrases in English (Model C, 2).

Strategies (a) and (b) are common in ESL teaching[4] and acknowledged as "good practice". They are bound into pedagogical situations where learners are seen as active meaning makers, and hence provided the opportunity to discuss their ideas. This also accords with Levine's (1993) research on second language teaching developments (in ESL) that emerged as "good practice" for all language teaching. The latter strategies discussed above are more linked to traditional teaching modes. Each strategy, of course, brings its own dilemmas and these are dealt with in the next section.

At this point, readers might well be asking: Surely all this holds for *all* teachers? It does, but any subject area will have its own specificity. In the words of one of the teachers:

> But it is complicated—like I said, they can hear what you're saying—the problem is the maths... they don't say "I don't understand the English you are speaking. It is the maths you did that they don't understand. But when they have to say it—saying it in English, that is the problem. (DET 4)

2. *Developing mathematical communicative competence vs. hearing meaning: or, when to model mathematic language, when to listen*? As argued earlier, and recognised by all teachers, it is not simply the English that is the problem:

> The problem (in group work—with discussion in any language, report back in English) is ... if all your discussion is in Zulu you get to the concept then you can't report back in English so you can't talk about it in English 'cos you never developed it in English—they don't develop the English to speak with. This is a difficult question—it can be dealing with the problem or making it worse—and now I want be able to explore it further. I am not sure which is better. If you start to try to develop the English while they are reporting then you can be putting words in their mouths instead of hearing what they have construed. (Model C, 1)

> ... like there are some kids who are really not good at explaining themselves, and I don't do anything to address that except to try to get them to explain it again because the class hasn't understood. And they still do it badly, and then I say can someone help him? And by listening maybe he will get the chance to develop. I haven't spoken to the English teachers about that but I want to because I am sure they have got strategies of actually developing a more exact way of communicating.
>
> And that would be an important thing to do?
>
> I am wondering. I don't know—these questions are starting to arise ... (Private, 6)

From both these accounts, learners clearly have difficulties in expressing their thinking—but it is not just any thinking—it is specifically their mathematical thinking. As we well know, mathematics is hard to speak (Pimm, 1987).

These accounts are from contexts of shifting pedagogy, from teachers whose pedagogical practice includes learners exploring mathematical ideas and then sharing these with the whole class. It seems that some learners need help to express their thinking both in English and mathematically. And this opens up two questions for teachers. One (latter quote) relates back to the opening question in the paper and that is recognition that help, specifically to talk mathematically, is needed, but mathematics teachers are not language teachers. So, where and how do such teaching skills develop? The second is when

and how to help so that as teacher you still listen carefully to what pupils are trying to convey, that you do not undermine student meaning by prematurely re-expressing or remodelling how it is expressed.

3. *Explicit mathematics language teaching.* The need for explicit mathematical language teaching was discussed by both Model C teachers in their interviews:

> as you were talking, something struck me ... is the assumption that everyone understands English ... you'll say ... I can't think of an example ... at points when I give an instruction, I write up the word on the board so that no-one is unclear of what it is and I have realised how many kids from English-speaking homes never knew that word, the one I wrote up was the one I was saying and that was interfering with their maths a lot ... I can't think of an example, but it has happened to me several times. Where I would have assumed a few years ago in an all white class I would have just gone ahead and talked away and now because there were black children in my class and I was writing up in a conscious effort to explain the English that I suddenly realised it was benefiting the English-speakers as well. (Model C, 1)

> As I have said it has made one more aware of being careful about how you present things because you know there will be kids who don't understand everything you say. Whereas before you just assumed that because kids spoke English at home they could understand everything you said, but they don't, and having the other children there makes you aware that they don't understand the more adult words—more aware of language.

and later

> I think one notices it more with the black kids 'cos it is just so obvious. But there are some of the other kids who I only realised afterwards weren't quite sure what I was on about and they had been too scared to ask ...
>
> I: that is interesting—they get hidden?
>
> Yes, especially it if is a big class and everybody seems to be carrying on and working away and it is only when you come and look underneath that little hand to see what is going on that you realise nothing is going on. (Model C, 2)

These teachers' experience is such that explicit teaching does help, and it helps everybody. Pimm (1987) and Mouseley and Marks (1991) also advocate explicit teaching of aspects of the mathematics register, and its different "genres".

A Deep Tension, for Some Even a Paradox

But the value of explicit teaching exposes a deep pedagogical tension: New pedagogy asks for opportunities for learners to make mathematical meaning and for teachers to listen to, build on, and interact with the meanings learners bring and make. This is in tension with explicit mathematical language and genre teaching and both in different ways are about access to mathematical processes and its products for all learners.

There are also strong interpretations of constructivism that conflate or reduce teaching to *intervention in children's meaning-making.* For teachers who hold with this view, explicit teaching presents a paradox.

What is also interesting is the absence of both miscommunication and the need for more explicit teaching in the interviews with the DET teachers. Accounts of communication difficulties were ascribed either to English as language of instruction or to mathematical language but not what could be called "culture and communication" issues.

4. *Culture and communication.* Three of the four English-speaking teachers in private and Model C schools told stories of communication breakdown. The most illustrative two are:

> (setting classes off on investigative tasks...)
> Its language as well. We tried to explain it to the Std 5's in terms of exploring, like what do you do when you are exploring? You go looking for something but you maybe find other things along the way, and you try to... we couldn't talk about explorers in history because they hadn't done that. We talked about exploring an area like town or a new place for the first time like (school name) when you first get there how you explore it. But it didn't really help as an analogy ... I don't think, it may later ... but a lot of them maybe just didn't understand what we were saying... I mean the actual English I think may have been a problem with the Std 5s. (Private, 6)

> I am not sure if I can explain them but they happen ... e.g. we developed a test (algebra) where they had to develop a pattern... the little squares that form a T ... we set that as a group-work test so part of the assessment was working as a group etc., and then apart from solving and handing in something written as a group, they had to explain what they did as a presentation to the class. The other three classes managed. My bridging class didn't begin to handle the task and we had done 3 weeks of investigation, whereas the others had only done 2 weeks, we had done 7–9 investigations and discussed, groups, explain

> on the board etc. nothing, nothing, nothing, nothing, handed in pages of nothing, nothing it was weird. (Model C, 1)

These are incidents of communication breakdown. Why did they happen? The teachers' struggles to interpret them point to the complexities of culture and communication. Whether it is about writing a test as a group, or doing a mathematical investigation, these pedagogical practices carry with them cultural assumptions about being in a particular school and in the mathematics class. They are clearly not simply about English proficiency nor mathematical skill, but about these within classroom cultural processes. They are situations where all three dimensions of multilingualism and mathematics learning in school are in interaction, and the most difficult to interpret.

Discussion

In this paper I have posited that if the multilingual nature of South African society demands that *all* teachers develop appropriate and developmental pedagogical practices for their multilingual classrooms, we need to examine the dynamics of multilingualism and mathematics teaching to identify what such practices entail in mathematics. An analysis of literature in the field of language and mathematics education suggested that this dynamic is three-dimensional, that is, it is about developing English, developing mathematics in English, and both of these within the social and cultural processes of school mathematics. Yet very few studies have attended to all three in their interaction. In addition, there appears to be no study that explicitly draws on teachers' knowledge of the issue. Given that teachers in multilingual settings face situations that might otherwise be taken-for-granted, their knowledge is an important source in understanding the dynamics of multilingual classrooms and mathematics teaching and learning.

The teacher accounts presented in this paper reveal that to a greater or lesser extent, mathematics teachers in multilingual settings in South Africa are already multilingual teachers. By this I mean they have developed some practices and strategies to deal with and enable the multilingual learners in their mathematics classrooms. Some practices, for example, explicit mathematics language teaching, encouraging public reporting in class in English constitute "good practice" for all learners. It makes sense then that these should be captured, shared, and developed with other teachers.

But any and all practices always have multiple effects. What these mathematics teachers' accounts also show is that in their multilingual settings they *do* confront situations that would otherwise be taken for granted, and some of these situations produce dilemmas.

DET teachers face what I called the dilemma of when to speak in the vernacular, particularly at the junior secondary level. Because they are bilingual, they can shift in and out of English, and the manner and extent to which they do this seems to relate both to the context of their school and their own theories, thus reflecting curriculum as relational. The importance of English, however, creates a pressure to teach in English and hence the dilemma for teachers, which the literature appears not to have really discussed. The problem seems to disappear in the senior school, and thus it would be interesting to identify how this happens. What is it that teachers do? What are their theories-in-action?

Obviously, the extent of English spoken by the teacher is not an issue for English-speaking monolingual teachers. These teachers, however, face other dilemmas as they confront the otherwise taken-for-granted in their particular settings.

Teachers who have attempted to change their pedagogy face dilemmas I called developing mathematical communicative competence vs. "hearing meaning". In multilingual classrooms where pupils are expected both to talk to each other about their mathematics and report back publicly on their thinking, different expressive competence is noticed. In such settings it is often difficult to work out how both proficiency in English and understanding of mathematics are implicated. There is thus less of a tendency to reduce difference in expression to the "innate" mathematical ability of the learner (the taken-for-granted) and more openness to see it as linked to language and thus possible and necessary to act on.

What I am pointing to here is that the multilingual context, while having its own layer of complexity (proficiency in the language of learning), alerts us to the issue of differential

communicative competence. This must be present in any and all classrooms, and it has not been taken sufficient cognisance of in research related to school mathematics reform initiatives.

Sociolinguists (Wilkinson, 1982) argue that communicative competence is both means and end in school learning: We need to communicate to learn, and learning is about becoming communicatively competent. If communicative competence is a means to learning, then it becomes crucial for teachers to assist learners develop this. The dilemma is how and when to act! What are appropriate and timeous mediational actions aimed at learners improving their expression of mathematical thinking? Premature actions could both silence the learner and prevent the teacher from really listening to the meanings the learner is trying to convey (Jaworsky, 1991). What kind of mediation? Scaffolding-type questions? Creating conflict? (Cazden, 1988). These are important conceptually, but what about mathematical conventions? Should these not simply be told? On the other hand, delayed mediation could be destructive for the learner and create confusion in the class.

Also sociolinguistically, the "genre" movement (see Mouseley & Marks, 1991) has argued that peer discussion and reporting are two different tasks, and that particularly something like reporting skills should not be left to chance, but explicitly taught. Too much emphasis on process and pupils' meanings can inadvertedly perpetuate social difference by not making explicit to all learners exactly what is expected of them. Edwards and Mercer (1987) argue similarly from an educational psychological perspective.

These dilemmas of mediation are clearly neither new nor unique to multilingual classrooms. However, it is such settings that bring them inescapably to light. The crucial question for this research is how teachers ACT in the face of such dilemmas and this is addressed in general terms in the concluding section of this paper.

Linked to the need for explicit teaching of genres, or what Edwards and Mercer call the "educational ground-rules", is what I termed "explicit mathematics language teaching". This is a strategy consciously developed by teachers whose classrooms recently changed from being homogeneously English-speaking to being multilingual. They claim that it benefits all learners. They were forced to confront what they otherwise took for granted: that all learners in their class, irrespective of spoken language, were not equally competent in English. This diversity was previously hidden in a seemingly homogeneous class. Here again is "good practice" that needs to be further developed and shared.

Two interesting and difficult questions arise from this "good practice". The first is whether silence on this in DET teacher accounts suggest that aspects of diversity are hidden in the seemingly homogeneous "black" classroom? This is something to explore.

The second is the deep tension and paradox mentioned briefly above. New pedagogy, within which are more democratic ideals of listening to learners, of creating space for their creativity and meaning, of less authoritarian classroom practice requires teachers to stand back more. At the same time, such classroom processes rely on *communicative competence* in learners as a means of sharing their ideas with others. The tension is that if communicative competence is to develop in mathematics, and this is equally important from the perspective of democracy, access, and equity, then it requires mediation in general, and explicit teaching of ground-rules and conventions in mathematical language in particular!

A paradox emerges in the face of the strong interpretation of constructivism which insists that there be no teacher intervention into children's constructions of operational knowledge (Murray et al., 1992). While this in itself is questionable, there is a tendency in teachers to generalise this into "thou shalt never tell/show children ...". In the light of demands of multilingual classrooms, teachers face the impossible: to be both non-interventionist and interventionist at the same time.

This paradox is disturbing because the call for changing pedagogy is loud and clear, and needs support in its progressive ideals. Its effects, however, have not been subject to sufficiently critical research. It opens up the question: What is progressive practice in complex educational contexts? What is strongly supported here is that teachers need to develop multiple strategies and knowledge and awareness of when to use these.

Finally, accounts from some teachers categorised as "culture and communication" revealed situations that point to the interaction of English proficiency, mathematical understanding, and classroom culture. They are not

attributable to any one of the three dimensions of multilingualism and mathematics learning on their own. These were clearly incidents of communication breakdown that theoretically can be explained as follows: Attempts to communicate are through language, and in the classroom through a great deal of (though not only) verbal speech. In Vygotskian terms, this is cultural and historical. Language, as a bearer of meaning and motivation, is imbued with culture and history and hence not easily interpreted by learners with different cultural and historical experiences.

Practically, however, these incidents were difficult for teachers to explain and understand. They require further study, beyond the scope of the initial interview, as does the absence of such in DET teachers' accounts. Either these are somehow hidden, or in such contexts, this kind of breakdown is, simply, absent.

Conclusion

The main purpose of this paper has been to describe, interpret, and interrogate teacher accounts of their mathematics teaching in diverse multilingual settings. It is desirable to conclude by opening up two key questions that have arisen and need further exploration. The first is, obviously, what happens in practice? These accounts need to be followed up by classroom study. The second is how do teachers act in the face of the dilemmas described here? How are their mediating actions understood? Do they use a range of strategies and are these informed and conscious choices in the face of dilemmas or are they prone to what could be termed "defaults"—fallbacks to the familiar? My hypothesis would be that in many instances it would be the latter. If this is the case then teachers could well be assisted to become more informed and more effective in their already established roles as multilingual teachers. In this way they will not only recognise what learners need, but they will have acquired further knowledge and skills for informed action.

Notes

[1] Like Levine (1993), I use "multilingualism" and "multilingual classrooms" to mean classrooms where learners bring in a range of mother-tongue languages. This does not imply any deliberate multilingual teaching.

[2] The American "Standards" produced by the National Council of Teachers of Mathematics (NCTM, 1989) has been particularly influential.

[3] See Adler (1991) for a detailed description of 7 different mathematics classroom contexts in South Africa and their implications for curriculum policy.

[4] In conversation with English methodologist at the University of the Witwatersrand.

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