Strategies to Promote the Introduction of Dialogic Teaching in Multilingual Mathematics Classes

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In the Eastern Cape monologic talk limits the interactions of learners because they are reticent to express their mathematical reasoning in English, which is not their first language. This article describes the practices of one teacher who, after an intervention, used deliberate choice of language, questioning and the development of English skills to create a classroom climate conducive to encouraging the use of exploratory talk. The learners expressed their reasoning through code-switching, by using their first language or a mix of English and isiXhosa. This practice resulted in instances of identifiable exploratory talk where learners gave reasons for their suppositions and challenged each others' views. In this way the tension between teaching English language competence as an access to social goods, and teaching mathematics as an access to tertiary education and employment, could be addressed.

Keywords: Mathematics, Multilingual, Dialogue, Strategies

Introduction

The majority of the teachers in the Eastern Cape teach learners whose first language is not English, the language of learning and teaching (LoLT), in most mathematics classes. Classroom studies in several countries in Africa reveal that using an unfamiliar language compels teachers to use teacher-centred methods of instruction and teaching strategies are reduced to chorus teaching, repetition, memorization, and recall (Alidou et al., 2006).

Research has shown that even when learners are set tasks specifically for group interaction, their results are rarely productive (Webb & Treagust, 2006). Often in the Eastern Cape learners are seated in groups; however, this does not mean that they are collaborating. Experimental studies support the opinion that the development of sustained and focused dialogue between teacher and learner and learner and learner will help learners to solve mathematical problems and aid individual learning (Mercer & Littleton, 2007). Why then do we encounter so little dialogue in mathematics classes in the Eastern Cape?

In this article we map the background of dialogic teaching then describe a study to ascertain whether dialogic teaching could improve mathematical reasoning and numeracy skills in multilingual mathematics classrooms. Three teachers' practices had been observed over the period of an intervention, but learners' pre- and post-test results (on mathematical reasoning and numeracy skills) bracketing the intervention were statistically more significant in one class than in the other two. We investigated possible differences that could have led to the improved results in one particular class. This article explores the practices of one grade seven mathematics teachers who implemented dialogic practices and other strategies with significant effect.

Types of Talk

Transmission style teaching is not peculiar to South Africa, as the triadic pattern of teacher initiation, learner response, teacher evaluation (IRE) of classroom discourse is evident in many parts of the world (Webb & Treagust, 2006); however, when learners are constrained to using only individual mathematical words, with which they are conversant in English, their lack of confidence in communicating reinforces the IRE cycle. If the intention of the follow-up is to evaluate students' response and to transmit meaning, the discourse is defined as univocal. In other words, univocal discourse aims to produce an accurate transmission of a message. On the other hand, if the follow-up questions are designed to elicit students' contributory ideas that could modify the discussion, the interaction is defined as dialogic. A dialogic view of learning presumes that mathematics is created in the classroom through reasoning and argumentation between teacher and learner and learner and learner (Barwell & Kaiser, 2005).

Mercer and Littleton (2007) emphasise questioning as a strategy to enhance reasoning. They maintain that questions can serve many different communicative roles, for example, to test learners' knowledge; to manage classroom activities or to assess learners' understanding. They maintain that teacher questioning can be used as a function in the development of learner's own use of language as a tool for reasoning. Firstly, questions can encourage learners to make explicit their thoughts, reasons and knowledge and share them with the group or the rest of the class. Secondly, through questioning,

teachers can model useful ways of using language that learners can replicate in peer group discussions. Thirdly, questions can provide opportunities for learners to express their understanding and reasoning in utterances longer than the chorused one-word answers that are frequently elicited in Eastern Cape classrooms. In an environment where learners are not fluent in the LoLT it is difficult to create a classroom climate where the above three functions take place; however, this study indicates that under certain circumstances and using specific strategies, learners can make appreciable strides in developing mathematical dialogue.

Truxaw and DeFranco (2008) maintain that the mere presence of talk does not constitute meaningful talk nor necessarily lead to understanding, but that the quality and type of the discourse are crucial to lead to conceptual understanding of mathematics. They examined teachers' roles in the development of meaningful discourse in the light of types of talk – monologic talk, leading talk, exploratory talk and accountable talk. Mercer and Littleton (2007) focused on teachers' introduction of exploratory talk in class groups, where learners talked together in structured ways. They used exploratory talk as a tool for constructing knowledge and creating joint understanding by using collaborative problem solving among learners (Mercer & Littleton, 2007). Both research studies involved teachers whose first language was English. The question arises: Can similar dialogic teaching strategies be introduced effectively in multilingual mathematics classes in the Eastern Cape?

Truxaw and DeFranco (2008) define monologic talk which involves one speaker, usually the teacher, with no expectation of verbal response; leading talk occurs when the verbal exchanges have been controlled by the teacher and lead towards the teacher's point of view; exploratory talk can be identified when speaking without fully intact answers, analogous to preliminary drafts in writing; and accountable talk is talk that requires accountability to accurate and appropriate knowledge, to rigorous standards of reasoning, and to the learning community (Truxaw & DeFranco, 2008).

Mercer and Littleton (2007) use similar definitions in their analysis of talk, although they focus more on interactions between participants, usually learners, as opposed to teacher-learner dialogue. They describe disputational talk as talk where participants agree to disagree, but where no reasons for decisions are given; cumulative talk occurs when participants simply agree with each other's opinions without engaging with the issue; exploratory talk is the preferable mode of communication as defined by Mercer and Littleton (2007, p. 59):

> *Partners engage critically but constructively with each other's ideas. Statements and suggestions ... may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered. Partners all actively participate and opinions are sought and considered before decisions are jointly made... knowledge is made more publicly accountable and reasoning is more visible in the talk.*

Despite the obvious disadvantages of using English only, or English mainly, in Eastern Cape classrooms, teachers are faced with the challenge of not only teaching learners to be competent in English, the language of power and access to social goods (Gee, 2004; Setati, 2008), but also to understand mathematical concepts, which would open doors to tertiary education and career mobility. In order to address this dual goal, research has shown that learners should be encouraged to express their mathematical reasoning in meaningful dialogues using exploratory talk (moving towards accountable talk) with peers (Mercer & Littleton, 2007; Truxaw & DeFranco, 2008). The approach used in this study emulates the strategy of moving towards dialogic learning, as used by Mercer and Littleton (2007), which promotes learners' exploratory talk through dialogue so that their reasoning becomes apparent to their peers. However the study showed that in classes where there were evidences of exploratory talk, other strategies could be effective and complementary in enhancing mathematical reasoning in multilingual classes.

Methodology

This research report forms part of a larger study that was conducted in an interpretive paradigm of mixed method design, where qualitative data were gathered and analysed according to themes identified from observations in the classrooms; and quantitative data were analysed from learners' pre- and post-tests on mathematical reasoning and numeracy skills.

Three teachers in similarly resourced and situated schools were identified to undergo an intervention on the introduction of dialogic teaching practices. Their three grade seven classes formed the target group and three classes in the same schools, but taught by teachers who did not attend intervention workshops, formed the control group. The target group performed statistically significantly better than the control group in both mathematical reasoning and numeracy skills, therefore the data suggests that the introduction of dialogic teaching had a positive effect on the learners' learning. However, when mining the data of the target groups further, it transpired that one teacher's learners had out-performed the other two target classes. This article describes the practices of one teacher, Mr Graham, as he taught mathematics to 45 isiXhosa-speaking grade seven learners in English. We endeavour to tease out practices that enabled Mr Graham to teach more effectively than the other teachers.

The classes were visited by researchers before the intervention began in order to establish a baseline profile of the teachers' interactions in the classrooms, as well as to gauge the prevailing classroom climate. During the intervention regular visits were conducted so as to plan strategies to develop exploratory talk in the classrooms. The duration of the classroom observations, which spanned nine months, enabled the learners, and the teachers, to become accustomed to regular visitors.

Mr Graham planned a series of lessons during which he initiated the ground rules of exploratory talk collaboratively with the learners. Examples of ground rules were, amongst others: everyone in the group must participate, listen when someone else is talking, give reasons for all your statements, disagree if you have a different answer, but give explanations. He introduced triggers, in the form of mathematical concept cartoons, to reinforce the practice of the ground rules. The objective for using triggers was to develop dialogue between the learners using artefacts to initiate talk, then to extend the dialogic practices into curriculum exercises. The learners responded well to the triggers and observation indicates that they were able to use the tenets of exploratory talk with curriculum problems from their text books.

Observation Criteria

In order to evaluate the strategies evident in Mr Graham's teaching practices that seemed to be more focused than in the other two teachers' classes, the following criteria were targeted for observation: language used, questioning techniques, classroom climate, building English competencies and the development of exploratory talk. All three teachers used the strategies, but they were consistently evident in Mr Graham's classes where, at times, a combination of strategies was implemented during one period.

Language used

Although Mr Graham spoke almost exclusively himself in English, and revoiced the learners' concepts in mathematical English, he did not constrain the learners to use English. He was able to balance the need for mathematical understanding with the need to develop English competence. The language the learners used was not an issue. It thus became invisible as mathematical understanding was foregrounded (Setati, Molefe, & Langa, 2008). He encouraged the learners to use either code-switching or their first language by advising: *"Please feel free to do it in isiXhosa so that you can understand it"*.

Mr Graham repeated the pronunciation of the mathematical terminology and revoiced mathematical properties that were being discussed, *"It's a rectangle! A quadrilateral with both opposite sides equal is a rectangle"*. The repetition of both the vocabulary and the mathematical properties reinforced the English terminology as well as the mathematical concept. He also revoiced for emphasis, to ground the concept in the learners' minds and to model correct mathematical terminology:

> Learner: January Street and Shini Street, they are parallel.
>
> Mr Graham: Yes, January Street is parallel to Shini Street.

As well as repeating the mathematical vocabulary, he wrote the words on the board so that the learners' visual perception enhanced their auditory perception.

Questioning

Mr Graham continually encouraged learners to make explicit their thoughts, reasoning and knowledge and to share them with the group or the rest of the class. For example, he prompted learners to give reasons for their statements, *"Why is it not a square?"* The learners had been coached to qualify their statements,

> *"Because a square has four equal sides and with that 'square' only the opposite sides are equal. It is a rectangle"*.

Mr Graham seldom gave evaluative feedback but used Socratic questioning techniques in which he answered a question with yet another question. He prompted, *"So what is the figure called, then?"* or *"What do other people think?"* or, *"Do you agree with that or you don't agree with that?"* or, *"What do you think about what she has just said?"* He used questions to maintain interest and alertness and to discover if the learners understood what he was teaching.

Questions were also used to provide opportunities for learners to express their understanding and reasoning in order to develop exploratory talk: *"Now you have to give us a reason why you have written that kind of number sentence on the board. Why have you used that sort of number sentence?"* Mr Graham used open-ended questions, which lead to dialogic learning as there is no simple correct or incorrect answer. He guided the progression of the learners' thinking:

Mr Graham: If you are looking at the opposite sides look at the opposite sides of *all* your parallelograms. Is it the same in all parallelograms? The opposite sides, what are the relationships between the opposite sides?

Through non-judgemental questioning Mr Graham built up a classroom climate in which the learners were prepared to take risks. They initiated discussion and were prepared to ask questions of both the teacher as well as their peers.

Classroom climate

Mr Graham used pictures of children with the word problems he gave the learners:

> Mr Graham: These ideas are ideas from other children. Maybe the same age as you are. These are ideas from children in England. So they are just as you are. OK? Your ideas could be the same as those of children everywhere else.

In this way Mr Graham demystified mathematics by moving it from the domain of a difficult school subject to an ordinary, everyday experience, which is accessible to everyone. In an exercise he asked the learners to formulate their own word problems relating to curriculum calculations that were contextualised around their everyday experiences. In this way he brought mathematics into the realm of the learners' own experience. By asking the learners to use their own context to

formulate word problems they were drawing on their experience, isiXhosa fluency and emerging mathematical language.

He used words such as "we" and "us" to engender a sense of collegiality and solidarity; he used dialogue to scaffold the learners' reasoning and actively solicited learners' views, without giving evaluative feedback which could have closed down the, at first, tentative responses. In groups the learners stood over their desks to be physically closer to each other and used their first language, interspersed with mathematical vocabulary in English. Whenever some groups were quicker than others to complete an activity, Mr Graham praised them. The learners were visibly pleased with their achievements and smiled and used positive gestures and body language. At all times he was authoritative, bur not authoritarian.

Building english competence

Mr Graham repeatedly scaffolded the strategy, language and thinking skills that learners should engage in during problem solving. He modelled the language and vocabulary he wanted the learners to replicate in their peer group discussions, and when they reported back in plenary, but did not draw attention or allude to any mistakes the learners may have made previously. In this way he did not dissipate their self-efficacy.

He held up words written on a large piece of paper: *"I am going to give you some vocabulary which you must use. Because I can hear you say* ***la macala athe nca****. I would like you to use the correct vocabulary now."* He gave each group a vocabulary list so that they could take ownership of their new knowledge. They had something tangible to work with that scaffolded their dialogue. They were also able to match the sound and the sight of the new words. He pointed out that the learners would be using language skills (reading and talking) in order to develop mathematical understanding and critical thinking. Mr Graham also replicated the type of answers he required:

> Mr Graham: If I have written 'is opposite' I want you to be able to find streets which are opposite each other. I want you to be able to say, *"This street is opposite to a certain other street"*.

Mr Graham created a link between numbers and words: *"Now it is no longer just numbers. We have statements with words, problems with words in them. That is why we need to be able to work on problems with words in them"*. Mr Graham continually pushed learners to cross over from symbols to language, and vice versa, teaching mathematics reading and writing skills as well as developing mathematical understanding and language skills.

Through judicious use of strategies Mr Graham was able to link both English and mathematical learning without drawing attention to the language that the learners were using, but emphasising their mathematical thought processes and understanding.

Development of types of talk

In Mr Graham's classroom there were instances of disputational talk (*"The answer is R120". "No, it is R60"*) and cumulative talk (*"It is a parallelogram". "Yes it is certainly a parallelogram"*). He reminded them of the tenets of exploratory talk:

> Mr Graham: What I want you to do is read the problem first, discuss what it is about so that understand the problem. Think of ways that you can solve the problem and talk about them, but make sure you always tell us *why* you think what you do.

At the beginning of the intervention learners used gestures and a mixture of languages to communicate mathematically, albeit haltingly. In the following transcript three boys identified cut-outs of polygons from their properties:

Boy 1: *i-Square. i-Square ine* two opposite sides *ne yabona*. (He demonstrates with his hands the width and breadth of two straight sides)

Nale (indicating the top one with his hands);

nale ezantsi – (indicating the bottom one with his hands)

Two pairs *ja* two pairs.

Boy 2: *Okanye, ibe i*-parallelogram, *zilele,* (He demonstrates with his body indicating the sideways slant of the sides) *silele nje*.

Boy 1: So *yona ihamba* straight

Boy 2: *Ihlala*. Straight (He indicates the top and bottom using his hands)

Boy 2: *Zi*-adjacent (He indicates with his hands and arms, bringing his hands together in front and moving them away from his body).

Boy 1: *Madoda ithi lena i*-octogon *inee* sides *ezi* eight. *Ena* eight sides.

(The other two boys agree, nodding their heads as they write)

Boy 2: *Ndithi le -itriangle – i-triangle mos i*-always *ne ina* three sides. Three sides. *I-tri - itri – le-tri - ithathatba* tree (holds up three fingers) and then *ke ngoku le* angle *i*-angle. *I*-triangle. Three points *besithi tri*. (Because it gives you three points.)

Boy 1: *Madoda*. Wow!

Boy 2: *i*- isosceles triangle. Two are sides that are equal. One side is not equal.

The boys' gestures were as eloquent as their words. Mr Graham sensed this and had given them manipulatives which encouraged them to combine touch and speech. The movement and gestures gave the learners the means to express their thoughts and communicate relatively confidently, even if they did not yet have the mathematical vocabulary in either English or isiXhosa.

By the end of the intervention there were recognizable instances where learners engaged with each other, or with the teacher, in the creation of mathematics understanding. They were accustomed to challenging others' views and giving reasons for their suppositions:

Gugu: It means they marked down one third of R180. Because if you divide R180 into three pieces, one of those pieces is R60. So they took off one of those three pieces.

Lethu: I disagree with you. The money they bought that dress with is R60 ... so how much money did she save? That says that we must subtract the R60 from the R180 so we can find the change ... It is R120.

Gugu: I still disagree, because to me I think they marked down the R60. I don't think that she paid R60 for the dress. She paid R120.

By examining the semantics of the question *("The dress was marked down **to** one third..." not "marked down **by** one third...")*, the girls realised that they were approaching the word problem from different angles because of their conceptions of the prepositional meanings. Through dialogue, they were able to reach a consensus.

Discussion

The relaxed and collegial classroom climate contributed to the development of exploratory talk as, at no time, did Mr Graham admonish the learners or enforce a controlling presence. He allowed the learners to experiment with their embryonic mastery over both mathematical and ordinary English and scaffolded their efforts by providing artefacts, vocabulary (both written and spoken) and by revoicing their utterances in the correct style and vocabulary.

Mr Graham used questioning as a tool to deepen the learners' mathematical reasoning and to help them to verbalise their logic to each other. He used questioning, perhaps intrinsically, for the reason Mercer and Littleton (2007) propound: to develop the learner's use of language as a tool for reasoning, by making explicit their thought, modelling mathematical language and expressing their thoughts in words.

The premise that teachers should encourage learners to move along the continuum from traditional, univocal discourse, towards dialogic discourse, where exploratory and, perhaps accountable talk occurs, was illustrated in this study, although at times the discourse moved backwards and forwards on the continuum, depending on the focus of the lesson.

This article suggests that various strategies can be implemented in mathematics classes to increase the amount of dialogue. The language used in the classroom should become invisible, or transparent – communication should be paramount. The learners should switch to whichever language in which they can express their reasoning – either by code-switching, using their first language or using a mixture of both English and isiXhosa. The attitude of the teacher is vital in this respect as the transition between languages should be the learners' choice and not be enforced by the teacher.

The teacher can scaffold mathematical learning by judicious questioning with open-ended or Socratic questioning so that learners are prompted to give reasons for their answers and are stretched to think and to verbalise their thoughts. The classroom climate can enhance dialogue if it is non-threatening and the learners feel comfortable in voicing opinions without fear of retribution or ridicule. In this environment the teacher can cater for both the mathematical and language needs of the learners.

This article suggests that the development of dialogic teaching, in the form of exploratory talk, in mathematical classes can occur effectively if teachers are exposed to the theory and practice of discourse development through an intervention; however it is recommended that complementary strategies and practices could also be implemented to enhance learners' competencies.

References

Alidou, H., Boly, A., Brock-Utne, B., Diallo, Y., Heugh, K., & Wolff, H. (2006). *Optimising learning and education in Africa - the Language Factor. A stock-taking research on mother tongue and bilingual education Sub-Saharan Africa*. Paris: Association for the Development of Education in Africa.

Barwell, R. & Kaiser, G. (2005). Introduction: Mathematics education in culturally diverse classrooms. In R. Barwell & G. Kaiser (Eds.), *Multicultural Issues in the Teaching and Learning of Mathematics*. Special Issue of *Zentralblatt für Ditaktik der Mathematik (ZDM)* 37(2), 61-63.

Gee, J. (2004). *Situated language and learning: A Critique of traditional schooling*. London: Routledge.

Mercer, N., & Littleton, K. (2007). *Dialogue and the development of children's thinking: A sociocultural approach*. London: Routledge.

Setati, M. (2008). Access to mathematics versus access to the language of power: the struggle in multilingual mathematics classrooms. *South African Journal of Education,* 28, 103-116.

Setati, M., Molefe, T., & Langa, M. (2008). Using language as a transparent resource in the teaching and learning of mathematics in a grade 11 multilingual classroom. *Pythagoras,* 67, 14-25.

Truxaw, M., & De Franco, T. C. (2008). Mapping mathematics classroom discourse and its implications for models of teaching. *Journal for Research in Mathematics Education,* 39(5), 489-525.

Webb, P., & Treagust, D. (2006). Using exploratory talk to enhance problem solving and reasoning skills in Grade 7 science classrooms. *Research in Science Education,* 36, 381-401.