Using dialogue in Mathematics classes: Could it aid Mathematical reasoning?

Lyn Webb 1 and Paul Webb 2

1 Department of Mathematics Education, 2 Centre for Educational Research, Technology and Innovation,
Faculty of Education, Nelson Mandela Metropolitan University, South Africa.

lyn.webb@nmmu.ac.za, paul.webb@nmmu.ac.za

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 main language. This could contribute to poor Mathematics examination results. This article describes the practices of one educator who, after an intervention, introduced strategies, such as judicious questioning and revoicing, to encourage the use of exploratory talk in his classroom over a period of nine months. The learners were encouraged to express their reasoning through code switching or in their main language. 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, was addressed. The introduction of dialogic teaching could help to improve Mathematical understanding and reasoning.
**Introduction**

The Senior Certificate results released in the Eastern Cape at the end of 2008 revealed that over 54% of the candidates who wrote the Mathematics examination scored less than 30% (*The Herald*, April, 2009). The majority of the teachers in the Eastern Cape teach learners whose main language is not English, the language of learning and teaching (LoLT), in most Mathematical classes. 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?

Truxaw and De Franco (2008) 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). Truxaw and De Franco, as well as Mercer and Littleton, worked mainly with 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?

In this article I map the background of dialogic teaching as stated in the literature. I then describe a case study of one Grade 7 Mathematics educator who implemented dialogic strategies, which had been introduced through an intervention, into his multilingual Mathematics classes.

**Univocal vs dialogic discourse**

Discourse is defined as univocal if the intention of the follow-up is to evaluate students’ response and to transmit meaning, the. 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. Dialogic discourse is more likely to lead to conceptual understanding than univocal discourse (Alexander, 2004). A dialogic perspective of learning, based on the Vygotskian viewpoint that cognition is aided by socio-cultural processes, claims that dialogism is ‘practice-oriented’ and communication is seen as an ongoing process of negotiation between people and contexts (Barwell & Kaiser, 2005). 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; Wertsch, 1998).

**Types of talk**

Truxaw and De Franco (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. Truxaw and De Franco use the following definitions of talk: monologic talk 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 and De Franco, 2008, p. 492).

Mercer and Littleton (2007) use similar definitions in their analysis of talk. 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 Mercer & Littleton (2007:59) define, it is talk:

…in which 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.

In this article I describe a scenario where the educator originally used monologic talk and leading talk only, but was able to encourage his learners, through various strategies, to move along the continuum from traditional disputational and cumulative talk, towards dialogic discourse where exploratory talk was evident, with accountable talk as a possible, achievable goal.

Despite the obvious disadvantages of using English only, or English mainly, in Eastern Cape classrooms, teachers are faced with the dilemma of teaching learners’ competence in English, the language of power and access to social goods (Gee, 2004;), as well as teaching learners understanding of Mathematical concepts, which open doors to tertiary education and career mobility. In order to address this dual goal, learners should be encouraged to express their Mathematical reasoning in their home language in meaningful dialogues using exploratory talk (moving towards accountable talk) with peers. Research has shown that learners should be exposed to the Mathematical terms and concepts that are introduced by the educator in English at the beginning of the lesson, and ‘revoiced’ and embedded at the end of the lesson during whole class interaction (Moschkovich, 2007). As such, 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.

**Methodology**

This article reports on part of a larger study that was conducted in an interpretive paradigm where qualitative data were gathered and analysed according to themes identified from observations in the classroom. The practices of one teacher, Mr Maciki, are reported as he taught Mathematics to 45 Grade seven learners in a township school in Port Elizabeth. The school was relatively well-resourced; however the classroom was overcrowded and noise from the adjoining class filtered continuously through the partition separating the classes.

The classes were visited by researchers before the intervention began in order to establish a baseline profile of the educator’s 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 classroom. The duration of the classroom observations, which spanned nine months, enabled the learners, and the educator, to become accustomed to regular visitors.

Mr Maciki 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, you can disagree if you have a different answer. 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 well 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 Maciki’s teaching practices in the classroom, the following criteria were targeted for observation: language used, questioning techniques, classroom climate, building English competencies, development of exploratory talk. At times a combination of strategies was implemented during one period.

1) Language used

Although Mr Maciki 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. In fact he encouraged the learners to use either code switching or their main language: "Please feel free to do it in isiXhosa so that you can understand it" (Mr Maciki).

2) Questioning

Lerman and Zevenbergen (2004) claim that questioning is an integral part of classroom practice and note that different types of questioning influence the acquisition of knowledge and social interaction in the classroom. 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 educator questioning can be used as a function in the development of learner’s own use of language as a tool for reasoning. 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, in this study research has shown that under certain circumstances and using specific strategies, learners can make appreciable strides in developing dialogic discourse.

Mr Maciki continually encouraged learners to make explicit their thoughts, reasoning and knowledge and to share them with the group or the rest of the class. 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 concepts in the learners' minds:

Learner: January Street and Shini street, they are parallel.

Mr Maciki: January Street is parallel to Shini Street.

Mr Maciki 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, "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.

Through non-judgemental questioning Mr Maciki 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 educator as well as their peers.

3) Classroom climate

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

Mr Maciki: 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 Maciki demystified Mathematics by moving it from the domain of a
difficult school subject to an ordinary, everyday experience, which is accessible to everyone. 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, halting responses. The learners were visibly pleased with their achievements and smiled and used positive gestures and body language.

4) Building English competence

Mr Maciki 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. When they reported back in plenary, he 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. Through judicious use of strategies Mr Maciki 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.

Dialogic learning

There was a clear progression from cumulative and disputational talk at the beginning of the intervention, towards exploratory talk, as the following transcript of a dialogue illustrates.

Two learners were solving a word problem in English. As the researcher was close to
them they used English exclusively, which could have inhibited the use of more pronounced
exploratory talk. They did give reasons for their utterances and challenged and counter-
challenged each other's positions; however, the greatest stumbling block to solving the word
problem was an English grammar misunderstanding. The learners first read out the word
problem together as a chorus, then engaged with the task.

Gugu and Lethu: Sophia was very excited when she saw that a dress she wanted was on sale.
The price of the dress was R180.00, but it was marked down to 1/3 of its original
price. How much did she save?

Gugu: This question is how much did she spend — and then we find R60.00. I think
R60.00 is the money she spent.

Lethu: I decide otherwise because it is marked down. That R180.00 is marked down 1/3
so it was R180.00 but it is down R60.00. Now how much did she save from that
R60.00?

Gugu: She paid R60 for the dress so how much did she save? We are going to subtract
that R60 from that R180.00.

Lethu: I disagree because this thing is saying this dress was R180 and then they marked it
down one part of that R180.

Mr Maciki: Now look at the language there. Look at the language. It was marked down to 1/3
of its original price.

Lethu: Then it is R60. Now how much did she save?

Mr Maciki: I can see where you are coming from. Gugu, you are saying the new price is 1/3 of
the old price Lethu, you are saying they took 1/3 off the old price. Read it again
and see if you can decide who is correct? You see how the language makes a
difference. Just that one little word to if you changed it ‘to’ to ‘by’ you would be
right.

Lethu: Yes that is right. So the money she saved, it is R120.00.
Gugu: Yes I agree now.

The difficulties the girls encountered with the meaning of the question are apparent. They have to make meaning of the language in the context before they can make meaning of the Mathematical content. There is a reasonable amount of disputational talk, but also exploratory talk in their attempts to understand and find ways of working out the answer. This kind of exploratory talk interrogates the sum for meaning as much as it explores possible ways of arriving at a solution to the problem.

The dialogue between the learners reveals how the comprehension of the language in a word sum impacts on the ability of the learners to access their Mathematics knowledge and experience before reaching a solution. The issue is the misreading of the preposition. Learners have replaced 'reduced to' in the text with the phrase that they are most familiar with, which is 'reduced by'. The comprehension of the question changes the Mathematical operation entirely and leads to confusion about the correct answer. It takes close reading of the text to ascertain the correct meaning. It is revealing in that this instance illustrates how assumptions are made based on familiarity with a particular phrasing in the context of 'sales talk'. The question is misunderstood and time is wasted on carrying out incorrect Mathematics calculations which have, in fact, little to do with assessing the learners' Mathematical knowledge or competence but is a question of language being a barrier to learning and successfully completing Mathematics tasks.

Discussion

In this article I described a teacher’s practices that embrace dialogic teaching and result in meaningful, learner-centred discourse, despite having the same negative constraints as other similarly resourced schools.

In Mr Maciki’s classroom there were instances of disputational and cumulative talk; there were instances of teacher-talk; but there were recognizable instances where learners engaged with each other, or with the teacher, in the creation of Mathematics understanding. This resonates with Barwell and Kaiser’s (2005) definition of dialogic learning. The relaxed and collegial classroom climate contributed to the development of exploratory talk as, at no time, did Mr Maciki admonish the learners or enforce an authoritarian 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 (Lerman, 2004).

Mr Maciki 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 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, modeling Mathematical language and expressing their thoughts in words.

In the period reported, Gugu and Lethu used dialogue as a tool for constructing knowledge and creating joint understanding, even after a detour into the minefield of English prepositions. They were able to use the tenets of exploratory talk to make Mathematical meaning and to solve a word problem posed in English.

Conclusions

Research indicates that sociocultural influences have an impact on Mathematical understanding and learning. Dialogue and the type of talk in which learners engage can enhance Mathematical reasoning. 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.

This article suggests that various strategies can be implemented in Mathematics classes to increase the amount of dialogue. The learners should switch to whichever language in which
they can express their reasoning – either by code switching or using their home language. The attitude of the educator is vital in this respect as the transition between languages should be the learners’ choice and not be enforced by the educator. The educator can scaffold Mathematical learning by judicious questioning with open-ended or Socratic questioning so that the 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 educator 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 if educators are exposed to the theory and practice of discourse development through an intervention. If this were to occur on a broad scale perhaps the Mathematical prowess of Eastern Cape learners would be improved to the extent that the Senior Certificate average is raised to acceptable levels.

Bibliography


Poetic reflections concerning issues in multilingual Mathematics and Science education in South Africa

Lyn Webb¹ and Lesley Foster²

Mathematics Education Department, Faculty of Education, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa

lyn.webb@nmmu.ac.za¹; lesfoster@telkomsa.net²

Abstract

Students studying for a language module for an Advanced Certificate in Education in Mathematics and Science Education (ACE:MST) at Nelson Mandela Metropolitan University (NMMU) were asked to answer a questionnaire about their perceptions concerning language, language policy and their experiences in multilingual classes. Very often students give answers that would satisfy the lecturer. In order to open windows to their souls they were first asked to write poetry about their language experiences before they answered the questionnaire. The results opened a common ground of trust and sharing in the class that could not have been evident in a normal lecture environment.