

LEARNERS' HOME LANGUAGES SUPPORTING LEARNER ENGAGEMENT IN LINEAR PROGRAMMING

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The paper reports on a qualitative study that investigated the deliberate use of learners' home languages in the teaching of linear programming. The study involved a teacher and his Grade 11 multilingual learners in a township school in the East Rand, South Africa. The teacher was specifically focusing on using learners' home languages deliberately in the teaching and learning of linear programming. The paper shows that the teacher used learners' home languages to probe learners' understanding of the phrase 'at least', frequently used in linear programming. Learners' responses suggest that they drew on their home language for the meaning of the phrase. Learners explained the phrase at least in their home language as 'buncinci' in isiXhosa, 'bonnyane' in Sesotho and Sepedi and 'okungenani' in isiZulu. Learners also used mathematical English term minimum to explain 'at least'.

INTRODUCTION

The paper reports on a study conducted in a school East Rand, South Africa. The study investigated how a Grade 11 teacher deliberately used learners' home languages to support learner engagement with linear programming concepts. The focus of the analysis will be on learner engagement of the phrase 'at least' in a classroom discussion. The study was guided by the following questions:

1. How does a grade 11 teacher use learners' home languages deliberately to support learner engagement in linear programming?
2. How does the use of the learners' home languages support the learners' engagement with linear programming tasks during the lessons?

I examine a lesson from a Grade 11 mathematics discussion on the phrase 'at least' to illustrate how the teacher supported learner engagement with the concept. I use excerpts from the transcript of this lesson to illustrate supportive teaching strategies. Furthermore, the transcript shows how the learners drew on their home languages when interacting with the linear programming task.

During the lesson, the teacher's instructional strategies included encouraging verbal interaction in learners' home languages, active participation whereby learners were involved in the learning process and to explain to other learners the meaning of the concept in their home language. Analysis of students engagement with the task show that learners drew on their home language meaning of 'at least' and then introduced the mathematical language meaning 'minimum'.

FRAMEWORK FOR EXAMINING LEARNER ENGAGEMENT IN LINEAR PROGRAMMING.

Reform curriculum places emphasis on the important role of mathematics communication in the mathematics classroom. The most publicized evidence of this reform in South Africa takes the form of the National Curriculum Statement (NCS: 2003) for Grades 10 to 12. The NCS statement documents thus, “Mathematics enables learners to communicate appropriately by using descriptions in words, graphs, symbols, tables and diagrams” (p.9). In reform classrooms, the teacher is expected to organize instructions to include a wider variety of opportunities for students to discuss Mathematics including group work, class presentations and teacher led discussions. The opportunity to use learners’ home languages is created through such interpersonal interaction.

In addition to broadening the opportunities for students to talk in the classroom, emphasis on classroom communication carries the expectation that students will negotiate their informal meaning. According to Tharp & Gallimore (1988), the kind of discourse that promotes the negotiation of informal meaning is instructional conversation. Whereby the teacher listens carefully to grasp the learner’s communicative intent and shape the discussion to meet emerging understanding of the learners. They further argue that instructional conversation helps to form communities of learners in which learners and teachers assist in one learning.

Prior research has argued that teachers play an important role in providing learners with access to mathematical words and ways of talking (Khisty, 1995). In the study reported in this paper, the likelihood that learners learnt to communicate their mathematical ideas was maximised when they were encouraged to use their home languages to support their communication of ideas.

According to Khisty (1995) talk is a vehicle by which an individual internalises meaning and develop a sense of personal power in mathematics. Adler (2001) has argued that talk in a mathematics classroom raises dilemmas for a second language mathematics teacher. Therefore, the learners’ home language is a resource, which could minimise the dilemmas in a mathematics classroom of multilingual learners.

Fraser, Murray, Hayward & Erwin (2004) argue that when teaching mathematics, social interaction creates opportunities for learners to talk about their thinking and this encourages reflection in learners. They contend, “To verbalise what one is doing ensures that one is examining it.” (p. 27). As learners learn mathematics, they share ideas, which require them to convince others that the procedures they are using to solve tasks are valid; they have to use arguments that are convincing to other learners. Studies have shown that when learners share ideas they use their home language.

Research document challenges related to conversation about mathematical ideas in linguistically diverse classrooms (Adler, 1997; 1999; Gorgorio & Planas, 2001). The use of the learners’ home languages might minimize the challenges and give learners an opportunity to communicate their thinking to the teacher as well as their peers.

Communicating thinking involved explaining and justifying an idea, agreeing or disagreeing with a mathematical claim.

LEARNERS' HOME LANGUAGE(S) AS A RESOURCE

Research has presented the learners home languages as a resource for learning mathematics (Adler, 1998, 2001; Khisty, 1995; Moschkovich, 1996, 1999; Setati & Adler, 2001). These studies have argued for the use of learners' home languages as a support in the learning and teaching of mathematics. The studies seem to agree that to facilitate multilingual learners' participation and success in mathematics; teachers should recognize their home languages as legitimate languages of mathematical communication (Khisty, 1995; Moschkovich, 1999, 2002; Setati & Adler, 2001). The use of the learners' home languages in these studies is through code switching, mainly to provide explanation to learners in their home languages. In the study reported in this paper, the use of the learners' home languages was deliberate, planned and helpful. The argument is that learners would develop proficiency in the Language of Learning and Teaching (LoLT) while learning mathematics.

Moschkovich (1996, 1999) has shown that learners draw upon various resources such as gestures, experience, representations and code switching to make sense of mathematical task. In my view, learners must first have opportunities to make sense of the mathematical task in order to participate in solving and discussing it. The home languages might support learners to make sense of the task.

Educators have acknowledged language as a tool for teaching and learning. Mercer (1995) argues that people use language to get things done and to engage in their interests. Using language to get things done depends on how well one is able to communicate his ideas to other people and how those people understand his ideas. In most cases, instructions are passed on through talking or writing using a language that both parties understand. In the same way, a teacher negotiates meanings with learners in a language that they both understand. Learners use language to communicate amongst themselves and with the teachers. They use language to think (Orton, 1992) and Mercer argues that language is both an individual and a social mode of thinking. Thinking is a process that assists learning and thus language structures that are not fully formed may set hurdles in learning.

WHY LINEAR PROGRAMMING?

The Revised South African Curriculum places great emphasis on “the establishment of proper connections between mathematics as a discipline and the application of Mathematics in the real-world contexts” (NCS, 2003: 10) and highlights task solving as a means to achieving this. Linear programming provides opportunities for such an approach in the mathematics classroom.

Linear programming was introduced into the South African curriculum in the mid eighties, for study by Grade 11 and 12 learners taking mathematics at a Higher Grade

level. With the discontinuance of the Higher and Standard Grade differentiation, linear programming is now offered to all learners' studying Mathematics at Grade 11 level as from 2007. Therefore all learners are to have access, and be able to learn successfully. According to the new curriculum, learners are to develop flexible and integrated knowledge and learn through pedagogical orientation and processes that are learner-centred.

An emphasis on learner-centred practice is meaningful learning by advocating learners' active participation and involvement in the lesson. While on the other hand, learner conceptions and meanings are to be elicited, encouraged, valued, and brought into interaction with concepts and knowledge. Learner-centred practice is centrally driven by meaningful communication between learners and teachers, between learners themselves. Adler (2000b) has argued that such a curriculum requires cultural and social resources, thus the study explored how a Grade 11 teacher deliberately uses learners' home languages as a resource to support learners engagement in linear programming.

LEARNING MATHEMATICS

In this article, I use Realistic Mathematics Education (RME) perspective on what it means to learn mathematics to consider learner engagement with linear programming task. According to Freudenthal (1991), the main principle of RME is that in order for mathematics to be of human value, it must be connected to reality, stay close to the children and should be relevant to society. Freudenthal puts emphasis on regarding mathematics as an activity he named mathematising.

According to Treffers (1987), there are two dimensions of mathematising, horizontal and vertical. Horizontal mathematisation occurs when learners are mathematising contextual tasks and in the process, learners use their informal strategies to model the task when solving it. In my view, the learners' informal strategies can be expressed in their home language or the language of learning and teaching while interacting with the task.

Vertical mathematisation occurs when the informal strategies lead learners to using mathematical language to solve the task. Horizontal and vertical mathematisation happens through learners' actions as well as when they reflect on their actions.

THE STUDY

The study was undertaken in a high school in the East Rand, South Africa. The study involved a Grade 11 teacher and his Grade 11 multilingual class. The learners in the school were able to communicate in English even though English is their second language. The teacher's home language is isiZulu. He also understands seven other languages (English, Sesotho, Sepedi, Setswana, isiSwati, isiXhosa and Afrikaans). The class had 46 learners in total, 19 girls and 27 boys. All 46 learners were multilingual and could speak and understand at least five languages including English and their home languages. The learners' home language(s) were Sesotho, Sepedi, isiXhosa and isiZulu.

During the lessons, the teacher divided learners into groups according to their home language(s). I focused on one group of learners (isiZulu) when learners were working in groups because it would not have been possible to focus on the whole class. Focusing on one group enabled continuity in terms of what they were doing rather than moving from one group to another and getting small pieces from everywhere.

Data was collected through lesson observation, video recording, a learner questionnaire and interview. A Grade 11 class was selected because it is the level at which linear programming is introduced in South Africa. I specifically selected this class because of the teacher who was doing action research. The teacher was using the learners' home languages deliberately when teaching linear programming. A total of five consecutive lessons were observed and video recorded; copies of all material produced by the teacher were collected.

DELIBERATE USE OF LEARNERS' HOME LANGUAGE

The word deliberate is emphasised because the use of the learners' home languages is "planned and not impromptu as it usually happens with code switching in multilingual classrooms" (Setati, Duma, Nkambule, Mpalami and Langa (2007: 4). The learners' home languages are viewed as a transparent resource. The tasks given to learners are in multiple languages and there are occurrences where learners answer to the questions in their home languages. Learners are also encouraged to use their home language when interacting during the lessons.

The tasks presented to the learners involved mathematical authentic contexts like borrowing money, Mandla cinema, a farmer and a hairdresser. The selection of real world interesting and challenging task enabled learners to "experience a process similar to the process by which mathematics was invented" (Gravemeijer, 1994:90). In RME terms the tasks should be real in the minds of the learners so that they can experience mathematics as common sense (Freudenthal, 1991).

LEARNERS' HOME LANGUAGE SUPPORTING LEARNER ENGAGEMENT

From lesson one to lesson five, the teacher created an environment that encouraged learners to challenge one another. The teacher conducted a lesson in a way that the learners became free to ask one another for an explanation of concepts and they were free to communicate in their home language(s).

Analysis of the data shows that the learners' home languages were used as resource for the learners to think with and also to interact with each other. The teacher also was able to probe learners' understanding of specific terms used in linear programming in their home languages. The focus of this paper will be on one of the tasks given to learners on day one which is shown below:

Table1: Linear programming task

English version
a. If I say to you borrow me at least <i>R10</i> how much money do I need?

IsiZulu version

- a. Uma ngithi kuwe ngiboleke okungenani amarandi alishumi, ngidinga malini?

The task provided means of eliciting learners' meanings of the phrase 'at least'. Learner's responses revealed that some learners did not understand the home language meaning of the phrase 'at least' in the home language version. Lack of understanding was more pronounced when learners were expressing their views using English like in the following extract:

- 57 Mantombi Any amount below R10 because at least any amount below R10.
58 Teacher Asikhulumi I-English angithi asifuni English or Afrikaans ama foreign language sikhuluma ngesipedi, Uthi malini sisi [We are not speaking English because we don't want English or Afrikaans which are foreign languages we speak in Sepedi. How much do you say it is my daughter.]
59 Mantombi R10 Any amount below R10, any amount below R10

It appears that Mantombi's meaning of the phrase 'at least' is less than or equal to R10. This meaning is evident in utterance 57 and 59. This suggest that the teacher was able to identify lack of understanding which led to him to encourage the learner to draw on her home language, Sepedi, instead of using the phrase 'at least'. However, the learner continues to use English to show that her understanding of 'at least' R10 is any amount below R10. In the extract below, the teacher elicited ideas from other Sepedi groups to express their understanding of 'at least'.

- 66 Teacher Akesizwe omunye wesipedi, yes [Let us hear someone who speaks Sepedi].
70 Lsi Thishela bonnyane (*using gestures pointing downwards*)
71 Teacher Okey uthi ithi bonnyane, yes

The teacher deliberately interacts in isiZulu in line 66 to solicit other contributions from other Sepedi groups. According to Ndayipfukamiye (1994), a teacher uses language to seek learners' involvement. As a result, one learner from the other Sepedi group showed understanding of the phrase 'at least' by introducing the word 'bonnyane' in line 70, which means minimum amount.

The teacher provided an opportunity for the other home languages, Sesotho, isiXhosa and isiZulu, to express their understanding of the phrase 'at least' in the classroom. This suggests that the teacher wanted learners to use available language resources in the classroom. Learners showed understanding by introducing appropriate words as shown in the following extract.

- 85 Teacher Okey, okey asizwe la Xhakaza [Explain Xhakaza]
86 Xhakaza Kube ndingathi kuwe...Ngingathi ngiboleke iR10 buncinci bayo [This is what I can say to you can you lend me R10 at least.]
87 Teacher Okey, buncinci bayo [minimum]
88 Xhakaza Ngabe ufuna iR20, kodwa uzawuthi ngiboleke ubuncinci baloR20, iR10 [If you want R20 but you shall say lend me a minimum of R20 is R10.]
90 Teacher All right all right asizwe la listen

- 92 Mkhonza Lalomuntu lo imali ayidingayo, lomuntu lo uthi okungenani like okungenani like kube R10, ubuncane bayo kungabi R9 because makungaba iR9 angeke ngiyithathe, okungenani something uR10 ukuya phezulu. [The money the person needs, the person says at least R10, the lowest could be R10 but not R9 because the person shall not accept R9 at least R10 or above]

The above extract shows that learners developed some understanding of ‘at least’ by using appropriate words like ‘bonnyane’, buncinci, okungenani [minimum]. The teacher did not produce the meaning of the phrase ‘at least’ in learners’ home language but the learners were actively engaged in the learning process. The existence of such learner talk and participation can be understood as encouraging learner’s verbalisation of their thoughts. The teacher gave learners an opportunity to articulate, share, discuss, reflect upon and refine their understanding of the meaning they were dealing with.

The above extract suggest that the teacher also facilitated the exchange of ideas and also helped in sustaining the discussion in terms of enabling students to contribute by uttering statements like in utterance 90: “all right, all right asizwe la [what do you say] listen very carefully”. The teacher also repeated the ideas of the learners like in utterance 71 and 87 to sustain the interaction as well as encouraging the learners to use their home language.

By establishing this pattern, the teacher was able to explore the students’ ideas in their home languages. He provided opportunities for the learners to find the meaning of the phrase ‘at least’ in their home languages. Asking learners to think about the meaning in their home languages created an opportunity for them to think about the different ways in which they could express ‘at least’ in their home languages. Learners also demonstrated their understanding of concepts through examples expressed in their home languages. The teacher created opportunity for learners to construct knowledge which they were responsible for, according to Freudenthal (1991) guided reinvention. The use of learners’ home languages in this manner supported learners’ understanding and engagement with linear programming task.

The following extract, shows how the teacher drew on home language to help learners who did not understand the meaning of the phrase ‘at least’. In this extract, the teacher emphasised explanation in learners’ home language.

- 109 Teacher Awusayi-understand namanje? (You do not understand even now.)
 110 Mantombi Yes
 111 Teacher Iliphi igama elikudidayo namanje? (Which word don't you understand.)
 112 Mantombi U-at least
 113 Teacher U-at least
 114 Teacher Akesiyekele ngo at least sikhulume ngeSepedi, sithi bunyanne, [Let us forget about at least and speak Sepedi, say minimum]
 117 Learner Ngicabanga ukuthi..[I think that]
 118 Teacher ISepedi? [Is that Sepedi?]
 119 Learner Like ...
 120 Teacher Ngithi mchazele kahle ezwe [explain clearly so that he can understand]
 122 Teacher Eh Eh anibachazele kahle [explain clearly to them]

The above extract suggest that the atmosphere created by the teacher was not favoring competition and individual performance but enabled students to feel free to present their ideas. As a result learners who did not understand were not shy to express their views as shown by the above extract. Utterance 111 shows that the teacher wanted to make sure that the learner did not understand the phrase ‘at least’. The teacher encouraged explanation from other learners in her home language. This suggests that the teacher wanted the learner to understand the meaning in her home language. He discouraged other home language explanations as shown by utterance 118 where one learner offered an isiZulu explanation. During the interview, he pointed out that using learners’ home language enabled them to understand the concept.

Teacher Because eh I think to me eh if you understand something in your home language... it becomes easy for them to interact ...eh abantwana [learners] they need to understand their home language. ...even in the past they use to say to me uthishela ufundisa imaths ngesiZulu [our teacher teaches mathematics in IsiZulu] because I like doing that ... and I always try to explain to them in IsiZulu. And once you start doing that abantwana baya-understanda akufani noma ungakhuluma i-English waya waya [learners understand, unlike when teaching in English right through] they dont understand some time

The extract above shows that the teacher views the learners’ home language as a resource in the teaching and learning of mathematics. Furthermore, he makes an effort to ensure conceptual understanding by using learners’ home language in his teaching.

DISCUSSIONS

From the above discussion about the phrase ‘at least’, using learners’ home language supported learner engagement with the task and learners were able to draw on their home language and introduced appropriate words. They further gave examples to support their claims and in the process introduced the word minimum. The interaction between teacher and learners shows that the teacher encouraged learners to draw on their home language when explaining meaning of phrase to each other. This type of interaction enabled learners to understand the mathematical meaning of the phrase ‘at least’.

Learners defined ‘at least’ as minimum amount and in their home languages, ‘bonnyane’ in Sepedi and Sesotho, ‘buncinci’ in isiXhosa and ‘okungenani’ in isiZulu. In between, the content of the classroom talk as guided by the teacher, I can argue that the talk went through a progression in mathematical meaning which might be summarised as follows:

- From talk about ‘at least’
- Meaning in different home languages
- To minimum in mathematical meaning
- Reflection of meaning whereby learners gave examples

Looking at this sequence, there is a sense in which the activity involved a process of mathematisation as the teacher guided the classroom discussion. Learners’ responses suggest that they achieved the process of horizontal mathematisation when negotiating the meaning of the phrase ‘at least’ in their home language. Probing by the teacher

resulted in learners introducing the word ‘minimum’, which resulted in learners achieving vertical mathematisation.

How did the teacher achieve progressive mathematisation? That is shown by looking at the pattern in the communicative approaches used by the teacher and the responses by the learners. The teacher interacted with the students to find the meaning in the learners’ home languages. He also encouraged learners to use their home language. Learners gave meanings in their home language as well as examples to show that they were engaging with the task. Then shifted to mathematical language, minimum, to show progressive mathematisation under the guidance of the teacher. Table 2 summarizes the above argument.

Table 2: Negotiation of the meaning of ‘at least’

	Horizontal mathematisation	Vertical mathematisation
Concept	Meaning in different home languages	Mathematical language
‘at least’	Bonnyane (Sepedi, Sesotho) buncinci (Isixhosa) okungenani (IsiZulu)	Minimum, greater than or equal to

CONCLUSION

The paper has shown how the teacher used the learners’ home languages to probe learners’ understanding of the phrase ‘at least’, a concept frequently used in linear programming, to support learner engagement with the task. The teacher did not focus on one home language but encouraged other learners to participate using their home languages. Furthermore, the teacher did not ignore learners who had difficulty in understanding the concepts.

The teacher provided the opportunity by encouraging learners to use their home languages when interacting, to explain to each other in their home language. In the process, learners’ responses suggest that learners drew on their home language for the meaning of the phrase ‘at least’. Learners explained the phrase ‘at least’ in their home languages as ‘buncinci’ in isiXhosa, ‘bonnyane’ in Sesotho and Sepedi and ‘okungenani’ in isiZulu. Learners also used mathematical English term minimum to explain ‘atleast’. Hence, the deliberate use of the learners’ home languages did support learners’ engagement in linear programming.

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