

Culturally–Based Activities In Grade 9 Mathematics: Tensions And Possibilities From Practice

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Abstract

This qualitative case-study explored the potential of culturally-based mathematical activities for informing teaching and learning of two Grade 9 mathematics topics in the South African curriculum. Three Grade 9 mathematics teachers from one school participated in a collaborative school-based professional development intervention facilitated by an external subject specialist (mathematics teacher educator). Through mathematizing culturally-based activities, the research team indigenised (i.e. adapted to local culture) two Grade 9 mathematics topics. A teaching and learning unit was designed and implemented in five Grade 9 classes at the same school.

The paper analyses and discusses the impact of this intervention study on the participating teachers. Contrary to arguments that ethnomathematics may not be a viable route into ‘solid’ mathematics, we use the analysis from this study to counter such arguments, and propose that culturally-based activities are highly-useful yet underutilized vehicles as an entry point into academically proven mathematics. The paper demonstrates that the experience of designing, implementing, and reflecting on the intervention study had some positive contribution to participating teachers’ pedagogical repertoire. However, we note that although involving teachers in an activity like this might be worthwhile, some teachers expressed apprehension of working outside their comfort zones. Participation in this study led to teachers’ awareness of a mismatch between the materials developed in the intervention and those recommended by the Department of Education. This finding leads to an awareness of possible tensions associated with the use of culturally-based activities for mathematics teaching, and a need for critique in relation to resources for/in mathematics.

Keywords: professional development; comfort zone; indigenisation; mathematisation; culturally-relevant pedagogy

Background to the study

Educational reform is now creating challenges to the teaching and learning strategies. Some education reform policies indicate that learners should be getting education which is relevant to their cultures. South Africa has embarked upon a curriculum that strives to enable all learners to achieve to their maximum potential (Revised National Curriculum Policy, 2002). Curriculum outcomes encourage learner-centred and activity-based approaches. Policy statements for Grades R-9 Mathematics envisage learners who will “be culturally and aesthetically sensitive across a range of social contexts” (DoE, 2002: 2). Interestingly, some assessment standards require learners to be able to describe and illustrate the historical developments of some mathematical concepts in a variety of

historical and cultural contexts. Learners are also expected to be able to solve problems in contexts that may be used to build awareness of social, cultural and environmental issues. From a curriculum perspective, the inclusion of the local, historical and cultural contexts in the teaching and learning of mathematics suggests mathematisation of cultural activities. Valuing indigenous knowledge systems is one of the principles upon which the National Curriculum Statement (NCS) is based on.

The cultural placement of an educational system is probably the most relevant fact in modern development of education (D'Ambrosio, 1979). Many researchers have agreed that teaching must be related to its cultural and geographical context (Bishop, 1988; Kroma, 1996; Ascher, 1994; Gerdes, 1999; Mosimege, 2000, 2003; Madusise, 2010). The common consensus amongst these researchers is that mathematics is being perceived as dry, uninteresting and irrelevant because familiar subject matter and experiences that could be used to lay the foundations of the discipline, arouse learners' interests and challenge their intellect early in life have been largely neglected.

Most children attend school where indigenous mathematics rarely forms the integral part of the curriculum. These children are subtly and sometimes not so subtly indoctrinated with negative attitudes towards anything that is indigenous. Ascher and Ascher (1994) posit that the more teachers ignore the variety of culture in their mathematics teaching, the less learners will understand what they are talking about.

Part of the teacher's work involves coming to an argument for ethnomathematics as a cultural way of doing mathematics. This calls for a radical change on the part of the teacher in order to see mathematics incorporated in the real world as a starting point for mathematical activities in the classroom. For there to be a real possibility of implementing such kind of classroom activity, there is need to investigate the mathematical ideas and practices of the cultural, ethnic, linguistic communities of the learners. There has been a growing attempt to relate mathematics and science to some of the cultural background of the learners. Khisty, (1995) argues that learners of all background would benefit from the opportunity to learn about and identify with their rich mathematics heritage and on-going cultural practices. Mathematics correlates closely with human life.

Although these new understandings of mathematics teaching and learning may sound very good, the implementation and impact of explicit instructional strategy may not be widespread. This stagnancy in classroom pedagogy maybe in part related to the failure of educational research to adequately investigate and promote the relationship between teacher professional development and enhanced understanding of the required pedagogical shifts. There is widespread agreement that improving teaching and learning requires that teachers participate in high-quality professional development (Elliot, & Kazemi, 2007). Such professional learning communities are largely linked to teacher learning in and from practice. Effective teacher professional development has been characterised as being long-term, collaborative, school-based and focused on student learning (Hiebert, Gallimore, & Stigler, 2002). Little (1987) describes professional development as an activity that is intended partly or primarily to prepare teachers for improved performance in present or future roles in their schools (Desimone, 2009:182).

The current study linked the mathematical knowledge being taught in schools close to cultural villages to the knowledge and activities of the cultural villages themselves – interrogating connections between mathematics and indigenous knowledge systems. The need to do this research was motivated by the desire to implement the NCS demands on

linking mathematics teaching to indigenous knowledge. This then called for an engagement of mathematics teachers in a school-based professional learning community. The major aim of the professional development was to base the teaching of mathematics on the cultural background of the learners, using out-of-school, culturally-based activities. Thus extracting mathematical ideas from the environment and embedding them within mathematical instruction. Embedded instruction suggests building scaffold for the learners to construct their knowledge in the process of learning, instead of providing learners with prepared knowledge.

This paper traces the journey of extracting mathematical ideas from cultural activities at the cultural village, designing and implementing an intervention teaching and learning unit at Grade 9 based on the extracted mathematical ideas, and discusses the impact of this intervention study on the participating teachers. It addresses the following central research question: *What is the potential of mathematical ideas associated with activities at a cultural village for informing the teaching and learning of Grade 9 mathematics?*

Theoretical framework

The study is framed and guided by two interrelated learning theories: Ladson-Billings' culturally relevant pedagogy and Wenger's (1998) theory of learning as social practice. Ladson-Billings (1994, p. 17-18) defines culturally relevant instruction as a pedagogy that can empower learners intellectually, socially, emotionally and politically by using cultural referents to impart knowledge skills and attitude. On the other hand, situated learning regards learning, thinking and knowing as "relations among people engaged in, with and arising from the socially and culturally structured world" (Lave, 1993, p.67). Learning occurs with the practices of communities as social and cultural contexts. In this sense, knowledge is shaped by the contexts in which it is acquired and used (Eraut, 2000). Social component is a critical component of situated learning; learners become involved in a "community of practice" where they are working together (Lave, & Wenger, 1991). Ultimately, "cooperation, community and connectedness are also central features of culturally responsive teaching. Learners are expected to work together and are held accountable for one another's success" (Gay, 2000, p.36).

Wenger (1998) came up with a model showing meaning, practice, community, and identity as components of a social theory of learning. In this model identity is a way of talking about how learning changes who we are and creates personal histories of becoming in the context of our communities. Consequently, "culturally responsive teaching can be considered transformative, as it recognises the existing strengths and accomplishments of the students and then enhances them further in the instructional process" (Gay, 2000, p. 33). Also, besides addressing learners' achievement, the underpinnings of culturally relevant pedagogy help learners accept and affirm their cultural identity.

Wenger (1998) further argues that learning needs to be presented in authentic contexts, settings and situations that would normally involve that knowledge. Finally, by connecting mathematics learning to the authentic problems\ activities that have directed its development, educators can help learners situate the learning of mathematics concepts in the context from which the ideas developed.

The two theories were found to be relevant to the study as they can both provide a complex and powerful methodology which involves participation in a learning community which may

possibly leads to some identity transformation. Three mathematics teachers from one middle school in the North West Province of South Africa constituted a community of practice. These teachers and the researcher collaboratively used mathematical ideas extracted from culturally-based activities to enact culturally relevant pedagogy in their Grade 9 mathematics classes. In this paper we explore how mathematics teachers' participation in a professional learning community influenced their classroom teaching practices.

Methodology

Samples and sampling procedures

The sample in this study comprised of three mathematics teachers from one middle rural government school in the North West Province of South Africa and their Grade 9 learners. Purposive and convenience sampling was used to select the research sites (Patton, 1990). Merriam (2009) identifies purposive sampling as one appropriate sampling strategy in case-study design. Merriam (ibid) further adds that purposeful sampling is based on the assumption that one wants to discover, understand, gain sight; therefore one needs to select a sample from which one can learn the most. In this case, a cultural village was identified as the research site and mathematics teachers who teach at a school very close to the selected cultural village were focused on. A cultural village was selected with the belief that it is where the community's indigenous knowledge is preserved. The intention was to make the cultural village a mathematics teaching resource centre. A school close to the cultural village was chosen with an assumption that its members (including the school children) are quite familiar with the activities taking place at the cultural village.

Grade 9 was chosen basing on the argument that it is the transitional grade from general education training (GET) to further education training (FET) where students after Grade 9 are to choose between Mathematics and Mathematical Literacy. At Grade 9 learners are learning mathematics which combines aspects of both Mathematics and Mathematical Literacy. At Grade 9 learners (14 to 15 year olds) have more experience with mathematics than learners at earlier grades. Doing the study at FET level would have limited the number of participating learners as some learners might have perceived it as being linked to Mathematical Literacy and would therefore withdraw.

Data collection instruments and procedures

Data sources included video clips of cultural activities, video-based lesson observations (the lessons were taught by both the researcher and the teachers), two learner questionnaires, teacher and learner interviews, artifacts, such as learners' lesson journals, teachers' lesson reflective forms, transcripts from reflective meetings and learners' work (Merriam, 1998; Yin, 2003) which served as corroborating evidence to enrich the picture of teaching practices presented in the study. The multiple sources of data provided converging lines of evidence to enhance credibility of assertions (Yin, 2003). All video and voice recordings were transcribed and inductively analysed using narration to report the results.

Participating teachers were interviewed at the beginning and end of the study and they also completed lesson reflection forms at the end of each and every lesson taught. Learners completed two questionnaires, one at the beginning and the other one towards the end. Learners were also interviewed to probe further on what they had written on the

questionnaires and lesson journals. However, for the purpose of this paper only data from participating teachers is going to be used. Group discussions were carried with teachers when viewing video-clips from cultural village activities, when planning lessons and when reflecting on lessons taught.

Data presentation and discussion

Table 1 shows the participating teachers coded TR A, TR B, and TR C for confidentiality reasons. All the teachers had a minimum of seventeen years teaching middle grades (Grade 7 to 9) mathematics, which means they had gained some experience of teaching mathematics up to Grade 9.

Table 1: Biographical information of participating teachers

Case teacher	TR A	TR B	TR C
Qualifications	Primary teaching certificate (3- year full-time programme) ACE in Curriculum & Educational management (2-year part-time programme)	BA (3- year full-time programme) ACE in curriculum & Technology (2-year part-time programme)	UDE (3-year full-time programme) ACE in Maths & Natural Sciences (2-year part-time programme)
Areas of Specialisation	All subjects but more into Maths & Science	Science & Mathematics	General Science and Mathematics
Teaching experience	17 yrs.	23 yrs.	23yrs.
Grade levels taught	Grade 6-9	Grade 7-12	Grade 7-9
Number of years at the current school	3	21	23
Subjects currently taught	Mathematics, Technology & Natural Sciences	Mathematics	Mathematics and Natural Sciences
Number of years teaching Grade 9 Mathematics	7	12	8

Tensions at onset of study

In the initial meeting with the teachers at their school, the researcher introduced the research to the teachers and completed consent forms. Although the teachers finally agreed to participate in the research there was some resistance to some of the procedures. Teachers made the following remarks:

TR C: Do you want us to go to the cultural village with you? I do not think we have the time. Most of our afternoons are occupied. Every Monday we go to another meeting with the subject advisor from the Department. (TR C, Notes of meeting, 23\01\2012)

TR B: We are familiar with the activities at the cultural village; even our learners are also familiar with the cultural activities which take place at that village. Some of our

learners participate in the cultural activities such as dancing, at the cultural village. (TR B, Notes of meeting, 23\01\2012)

R: Ok in that case maybe we can use the video clips of the activities which I took during my site seeing visits at the cultural village. Maybe through observing and analysing the films we can come up with something.

TR C: I can give you my classes so that you work with the learners in the afternoon. This idea of wanting us to teach together is not what other researchers have been doing. All those researchers who have been coming here interviewed us and gave us some questionnaires to complete. That is what we are used to. (TR C, Notes of meeting, 23\01\2012)

TR A: Why don't you use few learners – maybe one class, not all the five classes? (TR A, Notes of meeting, 23\01\2012)

The above statements indicated some tensions at the initial stage of the study. We were concerned about what would happen if all the research participants were to withdraw. The message we got was that the participants had signed the consent forms because the principal had signed hers so they did not want to go against their principal. To them participating in the study sounded like a top-down exigency.

The same negative sentiments were echoed again in the discussion meeting held to extract mathematical ideas from video clips on cultural activities. Comments such as the following came from the teachers:

TR C: Are you going to use all the Grade 9 learners? Why can't you pick a few kids and you test with a few kids like twenty. (TR C, Transcripts of discussion meeting, 01\02\2012)

R: The idea is to do it with all the Grade 9 learners, so that if it means learners will benefit we won't disadvantage other learners.

TR B: For us we can teach all of them but for you, for your research, you can have a handful of them and then... (TR B: Transcripts of discussion meeting, 01\02\2012)

TR C: Why can't you select a few and then **you teach** them (emphasis added). What I am saying is if you can select a few kids and you are with them that mean you will have less time. (TR C: Transcripts of discussion meeting, 01\02\2012)

R: But the idea of my research is to core-teach. Yes I can teach some of the lessons and you also have to teach others.

TR C: To teach? (Emphasis placed again). We may end up saying you are wasting our time because most researchers just give us questionnaires and say tomorrow I will come and collect the papers. (TR C, Transcripts of discussion meeting, 01\02\2012)

R: Maybe it depends on the type of research, because for this study we would like to implement the ideas we have drawn in the Grade 9 classrooms. And I am proposing that we do it together.

TR B: But if we meet and have discussions like the one we have just held we can benefit. We now know the mathematics which those people at the cultural village use. We also know where we can include the ideas in our Grade 9 teaching. We have gained a lot. Now we know what we must do when we go to the class. (Transcripts of discussion meeting, 01\02\2012)

The above remarks raise a number of issues. The first issue is on time factor. The teachers thought lessons like the ones discussed in the meeting would need time and they could not commit themselves to that. Secondly, teachers were not sure whether their learners were going to benefit from the study. That is why they had to mention using a small number of learners. Thirdly, the major reluctance was rooted in fear, fear of inconvenience, discomfort and even failure. They expressed apprehension of being observed by the researcher whilst teaching. According to them it was unusual as compared to other researchers who had come before us, therefore they were not comfortable with the arrangement. However the teachers seemed to be in support of collaborative group discussions on how to integrate cultural knowledge in the teaching and learning process.

Although the principal and the HOD had assured us of all the support, we were rather worried about the extent of the teachers' participation in the research, especially TR C, who showed no interest at all. She never participated in the extraction of mathematical ideas from the cultural activities even though others were rather curious and interrogating. It became obvious to me that teachers were not going to allow me to observe them teaching. This apprehension of working outside their comfort zone is in line with the HOD's remarks:

HOD: The challenge we are having with our educators is dedication and willingness to go an extra mile. Not all of our educators have majored in mathematics. Educators do not want to be embarrassed. But most of all our educators are not committed. (HOD, interview, 15\03\2012)

Individuals often couch their resistance to change in professionally accepted terms (for example, "I haven't got time to....) to mask deeply-rooted fears over the perceived limits of their own competences (Coffey, 2006). Chi-kin Lee, et al. (2011) recognise teacher commitment as a key to success in a school-based professional development. Experience suggests that a professional learning community, as a collaborative community of exchanging teaching experiences and improving teachers' pedagogical professionalism in a school, is tightly related to teachers' commitment (Chi-kin et al., 2011).

Teachers' existing practices

Table 2: Analysis of first interview transcripts

Subject issue	TR A	TR B	TR C	Comments
Use of textbooks	When combined the textbooks I am using are helpful. Teacher's guides are also helpful.	Textbooks are helpful because we use them. [Teacher's guides]....We use them also, they are helpful.	Textbooks and teacher' guides are helpful.	All the three teachers regard the textbooks and the teacher's guides they are using as helpful. TR A says he uses many textbooks and other textbooks are used as references.
Coverage of indigenous mathematical knowledge in the textbooks	There is not much really (emphasis added)	There isn't much	It is confusing because the children come from different cultures	TR A and TR B believe the textbooks they are using are not covering much of indigenous mathematical knowledge. TR C thinks what is in the textbooks confuses her it is not representing all the learner's cultures.

Improvising teaching materials on indigenous knowledge	To improvise! ... No I find it difficult. I find it difficult really. I always refer to what is in the textbooks.	I can improvise materials on other aspects....For cultural knowledge we use recommended textbooks and other textbooks as references.	No	All the teachers are not improvising any teaching materials on indigenous mathematical knowledge. They say they use recommended textbooks, but on the other hand they say textbooks do not cover much on indigenous knowledge. One then wonders whether the learners are learning anything from their cultures.
Classroom practices: Planning of teaching work	I just prepare starting from what they did. I refer to what they did before which is related to the same topic I would like to teach referring to their previous textbooks.	By following the curriculum. From the Department of Education they give us what to do for the whole year. We have schedules which come from the department.	Checking level of learners. Assessing the level of learners and their knowledge.	TR B looks at the curriculum and what it expects students to learn when planning to teach. TR A and TR C use the traditional way of planning where previous work has to guide planning. They value use of assumed knowledge.
Instructional strategies	I use chalkboard explanations. I introduce my lessons using examples from the textbooks. Theory: I believe they must be involved. Yah they must be involved so that they can understand.	Question and answer method. Demonstrations and giving instructions. Theory: I try by all means to make my students understand; I do not base my teaching on one method but I use different approaches.	Question and answer, explanatory and demonstrations. Theory: We follow given policies.	TR B: "I give instructions to tell them what to do, what the topic is all about and must ask them and they give me answers. We also show them how to get the answers." From the given reasons TR B uses question and answer to check if learners got what they must do. To check learners' understanding of the topic. To check if there are deviations from the required work. She uses demonstrations to show learners what they must do. TR C: "Because they have to know the formula". TR C uses question and answer to check if learners are following the formula. She uses explanation maybe to emphasise and summarise important ideas. TR A: "Since I use examples before, they can help me and my learners to see what they understand....." He uses chalkboard explanations maybe to facilitate understanding, illustrate an idea and examples are used to help learners understand.
Learners' role	Individual classwork, oral work, copying homework questions	Asking questions, oral work, group work and demonstrations.	Writing corrections, asking questions and explanation	TR A: "In fact I believe if they all participate, they must be involved". TR A gives individual classwork to make sure all learners participate in his lessons. To him active participation means engaging in individual classwork, oral work and copying home work.

TR B allows learners to ask questions to help them to identify problems\ misconceptions. Demonstrations are used because maybe she believes fellow learners might explain using simpler language.

In TR C's classes learners write corrections to identify misconceptions.

An analysis of the teachers' existing practices presented in Table 2 reveals that teachers base their teaching on recommended textbooks and other supplied curriculum materials. Their pedagogical strategies are influenced by instructional approaches of the materials (Rey, et al., 2003). Research has suggested that, mathematical topics\ ideas not included in textbooks are most likely not presented by the teachers (Freeman, & Porter; Rey et al., 2003). If the textbooks the teachers are using do not cover much of the indigenous mathematical knowledge and teachers do not improvise teaching materials (according to the above analysis), the conclusion one can draw is, there is limited link of mathematics education to learners' cultures. Studies based on the concept of cultural differences make an assumption that learners coming from culturally diverse backgrounds will achieve academic excellence if classroom instruction is conducted in a manner responsive to the learners' home culture (de Beer, 2010).

From the above analysis it can be observed that the case teachers' roles in the classroom can be classified into helping learners to remember what was learnt previously, checking if learners are following the lesson, helping learners to check misconceptions and conveying information. This observation indicates that the case teachers were not basing their teaching on learner thinking. It was also observed that their instructional strategies are not based on a clear theoretical framework as they could not clearly explain the learning theories which they use in their teaching.

Intervention teaching context

Two Grade 9 topics were taught using culturally-based activities in five Grade 9 classes. The Setswana step dancing was used to teach number patterns. Some Grade 9 learners demonstrated the dance and a number pattern was formed using the number of dancers and the number of steps per dancer. Some tasks were formulated using the artifacts from the cultural village. Step dancing was again used to teach substitution using number of dancers as input and number of steps as output. In another topic, artifacts from the Ndebele paintings and beadings, and Zulu baskets were used to teach properties of shapes and transformations.

Three lessons were taught in each of TR C's two classes and TR A's class. All the 9 lessons were taught by the researcher, while the class teachers were taking videos. Four lessons were taught in each of TR B's two classes. Three of the lessons in each class were taught by the researcher and one by the class teacher. Altogether 17 lessons were taught and video recorded. Reflective meetings were held after every lesson. Lessons were collaboratively planned by the researcher and the class teachers.

Issues from the analysis of final interview transcripts and notes of meetings

In analysing teachers' data, we found Cohen, et al. (2000)'s steps of analysing interview data very useful. Cohen, et al. (2000:148)'s steps start from the establishment of units of analysis of the data. The criterion here is that each unit of analysis (in our case, the issue), should be a fair rather than a distorted representation of the context and other data. To establish the issues behind teacher's data, we read and re-read the interview transcripts and notes from reflective meetings and came up with different subject issues. For the purpose of this paper we chose to focus on the final interview transcripts of TR B. We chose to focus on this particular teacher because of her commitment and participation in the activities of the intervention study. She is the only teacher who finally agreed to be observed teaching. Also her espoused claims of how her participation changed her thinking about teaching mathematics led us to her choice.

Perceived benefits of the intervention study on the teachers' practices

The cultural village as a mathematics instruction resource

Contrary to her contention in the first interview that she cannot improvise teaching materials on indigenous mathematical knowledge, but uses recommended textbooks, TR B, now affirms the cultural village as an instructional resource.

R: What have you personally gained from your participation in the study?

TR B: What I have gained is that I can use resources like culture....from cultural villages, like dancers (pause) to create, plan a lesson. (TR B, Final interview, 15\3\2012)

She contends that in the project all the required resources were available and all the used materials were designed using the cultural village as a resource. She believes learners can use the cultural village as a research centre to assist them to answer given mathematical tasks. She now sees the richness of the cultural village in terms of mathematical knowledge.

TR B: Yah....you can give the learners a task which needs them to go to the cultural village so that they can research more..... For this project we had all the resources we needed. Learners were actively involved and were able to answer tasks on their own. (TR B, Final interview, 15\3\2012)

These statements by TR B indicate some possible shifts in her perceived instructional practices. This sends a message that her engagement in the study impacted positively on her teaching practices. This is in line with Vescio et al. (2008)'s argument that well-developed professional learning communities can positively improve teachers' teaching practices.

TR B also notes the paucity of adequate curriculum materials and resources on indigenous mathematical knowledge. She affirms that curriculum materials from the department of education are minimum and do not include cultural resources. From these materials learners cannot see for themselves, she reiterates – a mismatch- because in the intervention study visual materials were used. Going through the learning outcomes in the given materials, TR B cannot see the link between mathematics and culture but in the study the used teaching materials clearly linked the two.

In her remarks TR B notes that by using resources from the cultural village learners were actively involved and were able to answer tasks on their own. Her exemplification provides

important insights into the authentic activities of the members of the cultural village which learners need. When such authentic activities are transmitted to the classroom, their context is inevitably transmuted; they become classroom tasks. Resnick (1998) proposes bridging of the gap between the theoretical learning in the formal instruction of the classroom and the real-life application of that knowledge.

Connecting school mathematics to the mathematics in learners' communities

It now seems clear that TR B now wants classroom mathematics to be connected to mathematics in the learners' communities. Teaching and learning resources can also come from learners' communities; she believes mathematical knowledge learnt from outside school can be **transferred** to the classroom. To her, linking or connecting constitutes the quality of mathematics content. However, transfer can occur when the transformed situation contains similar constraints and affordances to the initial context that are perceived as such by the learner (Bracke, 1998; Corte, 1999 cited in Bossard, 2008).

R: What do you think about the preparation required?

TR B: Just to link the mathematics and the culture..... I realised that most of them learn better when they see something and they can make connections.... I think we need to look at our environment and identify the places where learners can learn on their own using the environment. (TR B, Final interview, 15\3\2012,)

TR B sees mathematics as a human activity; she wants the content of mathematics in the textbooks to reflect this.

TR B: I think their content must be in relation with what we do in our lives every day that will be the most important thing for our learners. (TR B, Final interview, 15\3\2012)

This view embraces the practice of mathematics, its history and applications, the place of mathematics in human culture. Lerman (1990:56) sees mathematical knowledge as a library of accumulated experiences, to be drawn upon and used by those who have access to it.

Despite her comment in the first meeting that she was familiar with activities at the cultural village, TR B contends that the way she is going to see these activities is completely different now. She is now going to look for the mathematics being used in the cultural activities.

TR B: Yes now we are going to see activities differently, because we are now going to see different kinds of shapes, number patterns, colours, different colours used and all these are included into mathematics. (TR B, Final interview, 15\3\2012)

When describing the effects of the intervention study on students' learning, TR B emphasised that she had noticed a change in her learners' attitude towards mathematics. The use of culturally-based activities made learning interesting. TR B claims the more learners enjoy the more they learn.

TR B: I think by using the dancers this made the lesson funny for them and they enjoyed the lesson. The more they enjoy the more they learn. Then it has more impact on them than when they just read from the book..... the fun thing is that the learners were able to make their own explanations. (TR B, Final interview, 15\3\2012)

TR B: In my lessons only three or four learners participate, but in these lessons almost all learners participate. In groups I could see there were sharing ideas. I also observed that almost all the learners submitted the given tasks unlike in my previous

lessons. Most learners do not write home work. (TR B, Notes of reflective meetings, 21\2\2012)

It is observed that TR B was ready to critique her own lessons due to the perceived benefits of using culturally-based activities in the mathematics lessons. According to her, learners were involved in mathematical thinking because they could come up with their own explanations. Learners also made an effort to complete and submit given tasks, even the tasks given in her observed lessons. Shannon, (2007) posits that a realistic context will facilitate student success by intrinsically motivating students and thus increasing the likelihood that they will make a serious effort to complete given problems.

In addition TR B contends that before the project she could not see the mathematical educational value of the cultural village since it was never linked to mathematics education. The educational value of cultural villages was only attached to Arts & Culture, but not to other subjects. Maybe this is because of the suggestive name of the subject.

TR B: We haven't linked them with mathematics at all. This is the first time that cultural dancers or cultural activities were linked to mathematics learning. (TR B, Final interview, 15\3\2012)

The above contention sends a message that teaching maybe informed not only by the content of the discipline but also by the lives of the learners. An ethnomathematical or cultural view of mathematics argues that mathematics is an intrinsic part of most people's cultural activities (Ernerst, 2001). By attending to ethnomathematics, one can identify the broad and living informal cultural presents of mathematics.

TR B taught all the last observed lessons in her classes. In these lessons she used the cultural dance context to introduce linear graphs (an extension of number patterns). The number of dances represented the dependent variable x and the number of steps represented the independent variable y . This suggests that TR B had moved from the periphery to the centre of the community of practice.

Conclusion

The focus on culturally relevant pedagogy has brought with it sound pedagogical practices which the participating teachers perceived as making some changes in their usual teaching practices. Teachers saw the possibility of improvising teaching materials on indigenous mathematical knowledge through using cultural villages as resource centres. Instead of focusing on the fact that textbooks are unrepresentative of many of the cultural backgrounds of students in the classrooms, teachers can also bring in articles and resources that represent the knowledge, which supplements that which is presented in the textbook(s). The need for connecting mathematics to the environment is emphasised. A new value is attached to the cultural village – it is rich in mathematical knowledge and can play the role of a library as a research centre. The use of culturally-based activities can make mathematics more interesting to learn and to teach. Mathematisation can promote mathematical thinking in our learners. It is more useful to know how to mathematize than to know a lot of mathematics (Wheeler, 1982). Learners can reconstruct mathematical ideas and concepts based on their own experience of their environment. Culturally-based activities are highly-useful yet underutilised vehicles as an entry point to mathematics education.

A mismatch was recognised between materials designed in the study and those provided by curriculum planners. Some teachers expressed apprehension of working outside their comfort zone. They resisted being observed teaching. This discomfort was perceived as an indication of a possible lack of confidence (according to the HOD) or an indication of over adherence to the school culture. At the case-school lesson observation is a thing of the past. Also school-based professional development was new to the teachers. We recommend that case teachers need more help (based on their classrooms) to develop awareness of alternative instructional strategies. Therefore the case teachers need support to develop skills in using these alternative approaches such as culturally relevant pedagogy. Knowledge of such alternative approaches would help to make the case teachers' pedagogical strategies more flexible. Strong professional learning communities can foster the enhancement of teachers' professional knowledge and improvement of practice (Little, 2002).

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