

*Full Length Research Paper*

# Teacher learning in the context of curriculum reform

**Sylvia Madusise**

Department of Teacher Development, Robert Mugabe School of Education and Culture, Great Zimbabwe University, Masvingo- Zimbabwe.

Received 24 July, 2019; Accepted 5 September, 2019

**International studies on teacher learning communities (TLCs) emphasise that TLCs that are formed within the school context are powerful to help teachers improve their teaching practices. This paper presents a qualitative case study that analyses teacher-learning activities in a school-based professional learning community (PLC). The PLC aimed at staff developing teachers on how to connect mathematics education to cultural activities in the context of curriculum reform. Three middle school mathematics teachers participated in the learning community. Cultural activities performed at a cultural village very close to the school were mathematized. The embedded mathematics concepts were indigenised into the Grade 9 mathematics curriculum. Two teaching units on number patterns and transformations were crafted and co-taught by the facilitator and the class teachers in five Grade 9 classes. Data consisted of audio-recorded pre and post teacher interviews, video-recorded cultural activities, seventeen video-recorded lessons, and audio-recorded lesson reflective meetings. My analysis show how opportunities for teacher learning were created when modelling cultural activities, planning and teaching culturally-based lessons in Grade 9 mathematics classrooms. Results showed that teachers had opportunities to learn. There was evidence that the study had positive impact on teachers' pedagogical repertoire. One of the teachers even taught culturally-based lessons on other curriculum topics different from those done in the PLC. The focus on culturally relevant pedagogy brought with it sound pedagogical practices which the participating teachers perceived as bringing some changes in their usual teaching practices. My analysis also show the critical role of a facilitator for teacher learning in professional learning communities.**

**Key words:** Teacher learning, professional learning community, communities of practice, mathematics, indigenise.

## INTRODUCTION

In an international literature review of teacher professional development by UNESCO International Institute for Education Planning (2003), the concept professional development (PD) is perceived as being more than career development. It includes both formal experiences (such as workshops and professional meetings, mentoring) and informal experiences (such as reading

professional publications, watching television documentaries related to academic discipline etc). To give a more descriptive interpretation of professional development, the term is defined by Infanti (2011: 41) as "the process by which alone and with others, teachers review and extend their commitment as change agents to the moral purpose of teaching; and by which they acquire

E-mail: [smadusise@gzu.ac.zw](mailto:smadusise@gzu.ac.zw).

Author(s) agree that this article remain permanently open access under the terms of the [Creative Commons Attribution License 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

and develop critically the knowledge and skills for planning and practice with children, young people and colleagues through each phase of their teaching lives". Teacher professional development and professional learning are not the same but are closely intertwined. Timperley et al. (2007) argue that without professional development, professional learning is unlikely to have any impact. This means that any well-constructed professional development should promote learning. In relation to school context, professional development is viewed as being an integration of teacher learning with school improvement because learning is linked to what teachers do in the classroom and teachers' learning is collaborative and thereby allows them to effect changes beyond the individual classroom (Lovett and Cameron, 2011). Teacher learning communities embody the concept of teacher learning in a setting in which teachers come together over time for the purpose of their existing beliefs and practice gaining new professional knowledge and skills, reconstructing reform agendas that enhance student learning and professional practice (Chow, 2015). Therefore teacher learning communities (TLCs) are places where teachers are engaged in matters of special importance to them and where everyone is encouraging everyone's learning.

Many international research studies on teacher learning give a great deal of evidence that teachers learn when they are members of learning communities. Findings of the study conducted by Henze et al. (2009) in Netherlands suggest that teachers who learnt collaboratively kept engaged in specific professional learning activities for longer periods and felt more often confident at a start of the innovation compared to those teachers who learnt mainly individually. Teacher learning in professional learning communities is generally accepted as a teacher professional development approach that can significantly impact teachers' mathematical knowledge and practices (Brodie and Borko, 2016; Koellner and Jacobs, 2015). Day and Gu (2007), in their study on variations in the conditions for teachers' professional learning, find out that professional learning activities in relation to classroom knowledge have a positive impact on teachers' moral and are significant to teacher confidence in the classroom.

### **Mathematics curriculum reform in South Africa**

South Africa has embarked upon a curriculum that strives to enable all learners to achieve to their maximum potential (Revised National Curriculum Policy, Department of Education, 2002). Policy statements for Grades R-9 Mathematics envisage learners who will "be culturally and aesthetically sensitive across a range of social contexts" (Department of Education, 2002: 2). In this regard, the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives

(Department of Education, 2011). Interestingly, some assessment standards expect learners to be able to solve problems in contexts that may be used to build awareness of social, cultural and environmental issues. The National Curriculum Statement (NCS) challenges educators to find new and innovative ways to reach learners from diverse cultures in their mathematics classrooms. Valuing indigenous knowledge systems is one of the principles upon which the NCS is based. Part of the teacher's work involves coming to an argument for ethnomathematics as a cultural way of doing mathematics. The NCS calls for radical teaching practice changes on the part of teachers in order to see mathematics incorporated in the real world as a starting point for mathematical activities in the classroom.

Although these new understandings of mathematics teaching and learning may sound very appropriate, the implementation and impact of explicit instructional strategies may not be widespread and unproblematic. Teaching in schools rarely brings the interconnection between mathematics and culture in pedagogically informed ways (Mosimege, 2012). The NCS evinces weak classification with respect to the inter-discursive relations to allow the incorporation of indigenous mathematical knowledge in mathematics classrooms. Textbooks and teacher's guides lack sufficient local cultural mathematics content to enable the making of connections explicit in the context of teaching. From the prevailing scenario the question which came in my mind was, "Are the teachers enacting the expected culturally relevant pedagogy?"

Mosimege (2012) reiterated that mathematics teachers lack the ability to make connections in their mathematics classrooms; their indigenous content knowledge is shallow. Also, a report from the Task Team for the review of the implementation of the NCS (Department of Education, 2009) revealed that teachers had problems of converting the vision of mathematics teaching from the written into the taught curriculum. From the Task Team report, some teachers face mathematisation (mathematisation here is denoted as the activity or process of representing and structuring real world artefacts and/or situations by mathematical means) challenges when using social/cultural contexts to reveal the underlying mathematics while simultaneously using the mathematics to make sense of the contexts themselves.

The review report from the Task Team opened a gap for my study. Teachers needed to be professionally developed in order to be able to mathematize cultural activities and enact culturally relevant pedagogy as per curriculum reform expectations. To close the envisaged gap I then engaged the mathematics teachers in a professional learning community. In South Africa findings from teacher professional development studies have shown that teacher communities can support professional learning. Brodie's (2014) study showed how teachers

working in a community of practice learnt about their learners' thinking in making errors and developed better understanding of learners' thinking. Some professional learning communities provided opportunities for developing both content knowledge and pedagogical content knowledge (Marchant and Brodie, 2016), and have shown changes in teachers' knowledge of the curriculum (Brodie et al., 2010)

There is widespread agreement that improving teaching and learning requires that teachers participate in high-quality professional development (Elliot and Kazemi, 2007). Such professional learning communities may be linked to teacher learning in and from practice where mathematics education is connected to indigenous knowledge systems. Adler (2002) has suggested that such models should consider "a range of orientations... all of which cohere with the conception of teaching as knowing-in-action-in-context: learning to teach requires the study of the act of teaching". Effective teacher professional development has been characterised as being long-term, collaborative, and school-based and focused on student learning (Hiebert et al., 2002). Little (1993) 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 (Desimore, 2009: 182).

### Study focus

Driven by the proposal of the South African National Curriculum Statement (NCS) Grade R-9 Mathematics, to incorporate indigenous knowledge in mathematics education, the study from which this paper emerges sought to assist teachers in terms of where to access the indigenous mathematical content knowledge and how to integrate the extracted indigenous mathematical ideas in their mathematics lessons. This article addresses the following questions:

- (1) What changes, if any, occurred in the teachers' teaching as they participated in the professional learning community?
- (2) What did the teachers indicate as having benefited from their participation in the professional learning community as analysed from their narratives?

### Theoretical framework

Theoretical foundation to this study comes from Wenger (1998)'s theory which views that learning involves becoming a 'certain type' of person with respect to the practices of a community. In this view, learning occurs through "social participation" (Wenger, 1998: 4): learning "changes who we are by changing our ability to participate, to belong and to negotiate meaning"

(Wenger, 1998: 226). According to Wenger all learning eventually gains significance in the kind of person we become. Scholars within a situative perspective argue that knowing and learning are constructed through participation in in the discourse and practices of a community (Lave and Wenger, 1991). Learning is conceived as developing participation in a practice.

Guided by principles derived from a situative perspective, my facilitation roles in the study include creating an environment in which teachers' collectively explored ways of improving their teaching and support for one another as they work to transform their practice. This therefore provides a meaningful context for learning a professional learning community (PLC). PLCs is viewed as a subset of communities of practice, with their distinguishing feature of being professional learning. Professional learning must include becoming competent and confident with the knowledge base, using it to make and justify decisions and becoming both autonomous and accountable at the same time (Brodie and Borko, 2016). Situative theorists posit that contexts and activities in which individuals learn are fundamental to what they learn (Greeno et al., 1996). According to Putman and Barko (2000) teachers 'classrooms are powerful contexts for their learning.

Wenger (1998)'s theory is also used as an analytical framework to examine the professional development of mathematics teachers when designing and implementing an intervention teaching unit which incorporates indigenous mathematical knowledge in the teaching and learning of mathematics. Learning therefore involves active participation in a community of practice, where the concept of "situatedness" involves people being full participants in generating meanings. In communities of practice, learning arises from 'legitimate peripheral participation' which Lave and Wenger (1991) view as an enculturation process by which newcomers become part of a community of practice and thereby "acquire that particular community's subjective viewpoint..." (Brown and Duguid 1991: 48). Communities of practice theory therefore regards learning as 'socialisation', where increasing levels of participation within a community are the key to both how learning occurs and the formation of participant identity within it (Wenger, 1998).

### Samples and sampling procedures

The sample in this qualitative case study consisted of three mathematics teachers from one middle rural school in the North West Province of South Africa and their Grade 9 learners. Purposive and convenience sampling was used to select the research site. Merriam (2009) identifies purposive sampling as one appropriate sampling strategy in case-study design. Merriam (2009) further adds that purposive 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<sup>1</sup> was identified as a research site and mathematics teachers who teach 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 very close to the cultural village was chosen with an assumption that its members (including learners) are quite familiar with the activities taking place at the cultural village. There is tremendous potential for cultural villages to act as custodians of indigenous knowledge (Mearns, 2006). Visitors and workers at cultural villages interviewed by Mearns (2006) expressed that cultural villages conserve respective cultures they are representing.

## METHODOLOGY

To address the research questions, data sources included teachers' interview transcripts, lesson observations, teachers' reflective forms and transcripts from reflective meetings. These multiple data sources (Yin, 2003) served as corroborating evidence to enrich the picture of teaching practices presented in the study and the stories teachers tell about their engagement in the professional learning community. The multiple sources of data provided convergent lines of evidence to enhance credibility of assertions (Yin, 2003). Mathematics teachers were engaged in a school-based professional learning community, basing the teaching of mathematics on the cultural background of the learners, using out-of-school, culturally-based activities. The major aim was to extract mathematical ideas from the environment and embed them within mathematical instruction. Through mathematizing culturally-based activities performed the cultural village, the research team indigenised (transformed to suit learners' cultures) two Grade 9 mathematics topics in the South African curriculum. A teaching and learning unit on the indigenised topics was designed and implemented in five Grade 9 classes at the same school. The data comprised of seventeen video recorded culturally-based lessons from five Grade 9 classes, audio-recordings of teachers' pre and post interviews, notes from post-lesson reflective meetings with teachers and teachers' lesson reflective forms. In this paper, focus was on teachers' narratives from the post-lesson reflective meetings, the pre and post-interview transcripts triangulating data from lesson observations. The data were used to determine what the teachers valued as having benefitted from their participation in the professional learning community and also determine changes, if any, which occurred in the teachers' teaching.

Analytic induction involved reading and re-reading interview transcripts and notes from reflective meetings to unveil different subject issues. Responses were then classified on the basis of the formed subject issues (units of analysis). The three participating teachers are referred to as Teacher A, Teacher B, and Teacher C for confidentiality reasons. All the teachers had a minimum of seventeen years teaching middle grades (Grade 7 to 9) mathematics, which means they should have gained substantial experience of teaching mathematics up to Grade 9.

Prior to the engagement in the community of practice, teachers were interviewed to check on their existing practices concerning enactment of culturally relevant pedagogy. Questions asked were on the coverage of indigenous knowledge in the textbooks they were using, whether they were improvising teaching materials, and

their instructional teaching strategies. With respect to coverage of indigenous mathematical knowledge in the textbooks, the teachers made the following remarks in the interviews:

Facilitator: What is your comment on the coverage of indigenous mathematical knowledge in the textbooks you are using?

Teacher A: There is not much really.

Teacher B: There isn't much.

Teacher C: It is confusing because the children come from different cultures.

It can be seen from the above remarks that Teacher A and Teacher B believe the textbooks they are using are not covering much of indigenous mathematical knowledge. Teacher C thinks what is in the textbooks confuses her; it is not representing all the learner's cultures.

Facilitator: Do you sometimes improvise teaching materials on indigenous mathematical knowledge?

Teacher A: To improvise! No I find it difficult. I find it difficult really. I always refer to what is in the textbooks

Teacher B: I can improvise materials for other aspects. For cultural mathematical knowledge, we use recommended textbooks and other textbooks as references.

Teacher C: No, I do not improvise.

All the teachers were not improvising teaching materials on indigenous mathematical knowledge. They said they used textbooks recommended by the Department of Education, which from the above remarks, they had evaluated as not covering much on indigenous mathematical knowledge. This is also illuminated by the above excerpts. Teachers were basing their teaching on recommended textbooks and other supplied materials. Their pedagogical strategies were influenced by instructional approaches of the materials (Rey et al., 2003). Research has suggested that mathematical topics/ideas not included in the textbooks are most likely not presented by teachers (Freeman and Porter, 1989).

However, my analysis of the textbooks teachers were using revealed that they did not cover indigenous mathematical content. The textbooks the teachers and learners were using did not cover much on indigenous mathematical knowledge and the teachers were not improvising teaching materials. The conclusion one can draw is that teachers were not implementing the pedagogical curriculum reform where teacher's work involves coming to an argument for ethnomathematics as a cultural way of doing mathematics. 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). Therefore professional development on culturally-based teaching was inevitable for the above teachers.

## Teachers' perspectives of culturally-based teaching at the beginning of the professional learning community

In the first group discussion meeting after viewing a video on activities at the cultural village, issues of collaborative planning, use of intellectual virtues, lack of resources and deprivatising teaching emerged. The video was shot at the cultural village.

Facilitator: Okay, these are the activities captured at the

cultural village. What we are now supposed to do.... is to pick the mathematical ideas they are using... After picking the mathematical ideas then we decide on where we can possibly use them... which topic or topics can incorporate some of the extracted ideas in our Grade 9 mathematics? I am not well-versed with the Grade 9 content.

Teacher A: We can see there is quite a lot of counting of steps when they are dancing... There are some geometric figures in their paintings.

Facilitator: You have identified some geometric figures in the paintings. Maybe we need to go further and think of the aspects we can teach using the pictures.

Teacher B: Shapes, angles and the properties of shapes.

Teacher A: We can use the pictures to teach transformations.

Teacher B: In fact there is a lot of reflection in the pictures.

Teacher A: There is also rotation.

Teacher B: See here at this picture (pointing at the picture), there is translation

Teacher C: From these other pictures we can also teach similarities.

Teacher B: It is even more to that, we do have some shapes which are exactly the same in shape and size – so we can use these shapes to teach congruence.

Teacher A: From those rhombuses and other shapes we can ask learners to identify shapes and their properties.

Teacher C: No we cannot have a lesson where we can say today we want to teach counting but the ideas can be used say when teaching or introducing number patterns, for example, using number of dancers and number of footsteps per dancer, to come up with a number pattern.

Teacher B: We can benefit. We have gained a lot.

By telling the teachers that I was not well-versed with the Grade 9 mathematics content, I indicated to the teachers that they were expected to be active participants. Thus giving them almost full responsibility of the planning session. This led to “positive” cooperation from all the three teachers.

The “collective responsibility” given to the participants also led to an element of “trust”, trusting that what they were giving was of value to their learning and also to me as I had indicated the possibility of wanting to also learn about Grade 9 mathematics content. The flow of extracted mathematical ideas coming from the teachers indicated some “enthusiasm”, “satisfaction” and “sharing” of ideas in the participation.

Teacher B’s comments, “we can benefit”... “We have gained a lot” indicates that “collective participation” can be a powerful form of teacher learning.

Teacher B: For us we are going to have problems with resources if we are to teach as well.

Facilitator: No do not worry about resources that we are going to use in our lessons. We will discuss together what is needed then if it means going to the cultural village again; I will go and try to source the required

resources.

Teacher B did not seem to like the idea of teaching due to lack of teaching resources. This lack of indigenous knowledge teaching resources drew away her teaching “confidence”. One then wonders whether the teachers were incorporating indigenous knowledge in mathematics education as per curriculum expectations.

Facilitator: The idea of this study is for us mathematics educators (you and me) to try to implement the extracted ideas together. We should all play the teaching role and the observer’s role. I teach a lesson while the class teacher observes and make comments.

The class teacher also teaches another lesson whilst I do the observation as well.

Then after the teaching we will have reflection meetings, reflecting on the taught lessons.

I tried to use what I thought was relevant information in the argument to try and reject the “flimsy reasoning” given by Teacher B against the idea of teaching together. I provided reasons immediately upon the participants stating their disagreement. Thus using intellectual virtues.

Teacher C: Why can’t you select a few then you teach them (emphasis added). What I am saying is if you select a few kids and you are with them that mean you will have less time.

Facilitator: It is not ...that is what I am not encouraging. The idea of this study is to co-teach.

Yes I can teach some of the lessons and you also have to teach some.

Teacher C emphasised not being prepared to be observed teaching. The idea of moving teaching from “isolated” activity to the public sphere of professional learning communities did not auger well with Teacher C. It looks like Teacher C was not against observing the researcher teaching but was against being observed teaching. She still wanted to play the “privatisation card”, not wanting outsiders to mingle with her teaching.

### Intervention teaching context

Two Grade 9 topics were co-taught by the researcher and the participating class teachers using culturally-based activities in five Grade 9 classes. The lessons were collaboratively planned by the researcher and the class teachers. A group of Grade 9 learners (these learners had previously participated in the cultural dances at the cultural village) demonstrated a Setswana step dance, a cultural dance practiced at the cultural village near the school. It was observed that the dancers were following a certain dancing style where each dancer was making five footsteps forward, backward and sideways. The modelling of the dancing style through class discussions produced a number pattern involving the number of dancers and the number of cumulative foot-

**Table 1.** A number pattern derived from the dancing style.

Number of dancers	1	2	3	4.....	n
Number of foot-steps	5	10	15	20.....	n x 5

steps made in one direction before change of direction (Table 1).

The second row was used to introduce a sequence. Through deductive reasoning the rule connecting the terms of the sequence was generalised. Learners managed to explain their understanding of a sequence leading to its definition. However, there was a heated argument on whether 'n' could take any value. Realistic considerations were recruited. Making 'n' = 0 meant no dancer, therefore no dance and making 'n' too large meant too many dancers dancing at the same time making it difficult to follow the dance. At higher levels the depicted scenario can be used to introduce bounded sequences. Given the periodic nature of the cultural dance – going forward, backward and sideways, the implied mathematics involved is periodic in motion since the steps were repeated over time. This led to another sequence - a constant sequence: 5, 5, 5, 5,...whose  $n^{\text{th}}$  term is 5.

In Teacher B's observed lessons, the same dancing context was used to introduce plotting of linear graphs. The number of dancers represented the independent variable  $x$  and the number of footsteps represented the dependent variable  $y$ . In her other lesson on 'input' and 'output', the number of dancers represented the input the footsteps represented the output.

In another topic, artefacts from the Ndebele paintings and beadings, collected from the cultural village (Figures 1 and 2) were used to teach properties of shapes and transformations. Two mathematics topics, "number patterns" and "transformations" were co-taught in seventeen culturally-based lessons in five Grade 9 classes.

### **Perceived benefits of the intervention study on the teachers' practices**

For the purpose of this paper I chose to focus on Teacher B. I chose to focus on this particular teacher because of her commitment and participation in the activities of the professional learning community. She even used cultural contexts in some of her observed lessons. Also her espoused claims of how her participation shifted her practices on connecting the teaching of mathematics to learners' cultures (implementing the expected curriculum reform) led me to focus my analysis on her practices.

Subsequently in this paper, vignettes are presented and commented on to demonstrate aspects of Teacher B's perceived benefits from the professional community of learning.

### **Vignette 1: Cultural villages as instructional resources**

Facilitator: What have you personally gained from your participation in the project?

Teacher B: What I have gained is that I can use resources like culture...from cultural villages, like dancers (pause) to create, plan a lesson.

Facilitator: Do you think the way you are thinking about assessment is now different from the way you were thinking about assessment before?

Teacher B: Before the project yes, it is different because we didn't prepare our lessons like we usually did in the project. For this project we had all the resources we needed. Learners were actively involved and were able to answer tasks on their own.

Facilitator: We are still talking about what we were doing before and how we think the project has influenced the way we may do our work in future. Now do you think the way you are thinking about setting homework, class exercises, tests, is different from the way you were thinking before the project?

Teacher B: We have all the tasks included in the assessment programme. The problem is when we research students go to .....maybe the library, but there is no library which is nearer for the learners to use. They have to go to town for the library. And also if they want to research using the computers it is a problem as we do not have computers at our school. But we will now think of ...the cultural village...of using the cultural village and learners to go to the cultural village as it is nearer to them.

Facilitator: Ok, so you are saying now you can advise .....

Teacher B: Yah....you can give the learners a task which needs them to go to the cultural village so that they can research more.

Teacher B: Or to take them to some places, like to take them to a museum or a cultural village where they can see all these things.

Teacher B approves the possibility of using the cultural village as a mathematics instructional resource. She contends that in the project all the required resources were available but all the used materials were designed using the cultural village as a resource. To her the cultural village can play the role of a library. 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. According to Teacher B, one advantage of using the cultural village when doing



Figure 1. Ndebele paintings.

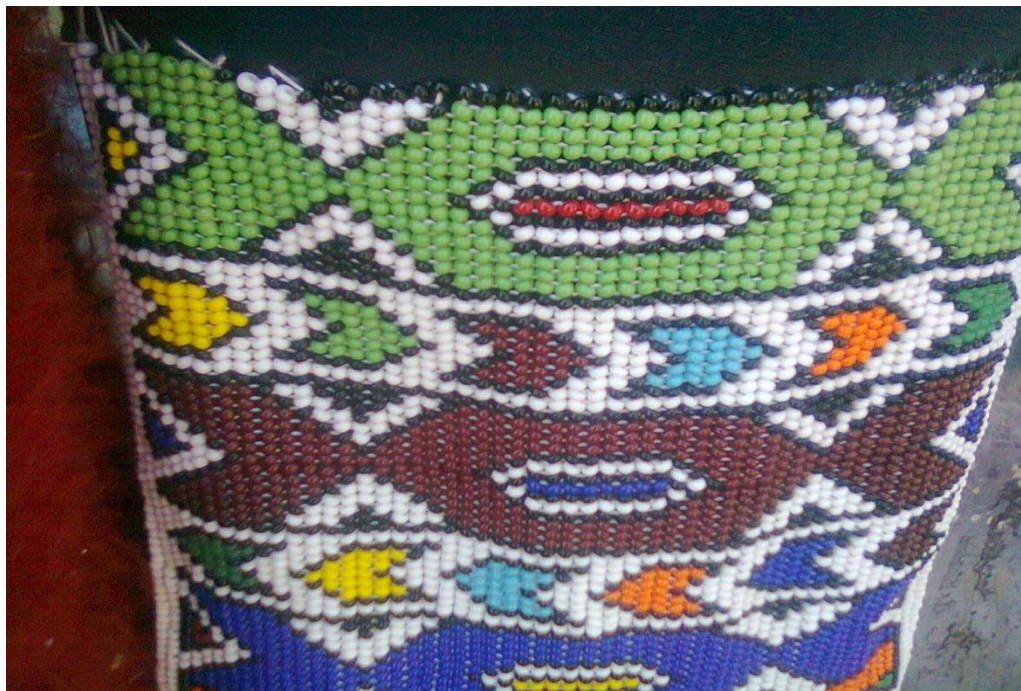


Figure 2. Ndebele beadings.

research is visualisation. “.....take them to the museum or cultural village where they can see all these things”.

**Vignette 2: Use of cultural connections in mathematics education**

Facilitator: What do you think about the preparation required?

Teacher B: Just to link the mathematics and the culture so that the children can see where these two topics, the culture and....how their culture integrates with mathematics.

Facilitator: You mean they need something like an educational tour.

Teacher B: Yah .....that is also important because I realised that most of them learn better when they see

something and they can make connections.

This is the first time that cultural dancers, or cultural activities were linked to mathematics learning.

Facilitator: What advice would you give to other mathematics teachers in general?

Teacher B: I think we need to look at our environment and identify the places where learners can learn on their own using the environment, where they can gain more using our own environment. Because maybe we can find out that it is not only the cultural village but they may also be some other resources here in their community which they can use and can benefit them in their learning. But then this can only be effective if the community and the school work hand in hand that will be effective.

Teacher B now sees the value of connecting mathematics to learners' cultures in her lesson preparations. To her, use of environment can assist learners to learn on their own, they can gain more using their own environment. By conducting educational tours which take learners to places where mathematics is being used, Teacher B believes learners can make connections. She now sees the need to link mathematics and culture when teaching so that learners can see how their culture integrates with mathematics. Teaching and learning resources can also come from learners' communities; she believes mathematical knowledge learnt from outside school can be transferred to the classroom.

### **Vignette 3: Effects of the intervention study on teachers' practices**

Facilitator: Do you think the way we used activities at the cultural village will shift the way you will see these activities when you visit the cultural village today or say in future?

Teacher B: Yes now we going to can 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 education.

Facilitator: Do you think the way you are thinking about assessment is now different from the way you were thinking about assessment before?

Teacher B: Before the project yes, it was different because we didn't prepare our lessons like we usually did in the project. For this project we had all the resources we needed. Learners were actively involved and were able to answer tasks on their own.

Facilitator: We are still talking about what we were doing before and how we think the project has influenced the way we may do our work in future. Now do you think the way you are thinking about setting homework, class

exercises, tests, is different form the way you were thinking before the project?

Teacher B: Yah....you can give the learners a task which needs them to go to the cultural village so that they can research more.

Teacher 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- a perceived change. Another perceived change is on her lesson preparation. She now has to design resources similar to those designed in the study. She now knows where to search for the cultural mathematics content- at the cultural village. In her questioning technique, Teacher B affirms she is thinking of setting tasks which can be answered using the mathematical content to be extracted at the cultural village.

### **Vignette 4: Mismatch between materials used in the study and those from the Department of Education**

Facilitator: What is the difference between the pedagogical materials we used in the project to teach the two topics and the materials which you receive for the curriculum implementation?

Teacher B: From the department?

Facilitator: From the department, yes.

Teacher B: Here we receive a minimum of materials which do not include cultural resources and most of them are books. Learners cannot see for themselves, they just read the books.

Facilitator: Comment on the coverage of indigenous mathematical knowledge in the textbooks you are currently using. Can you possibly comment especially on the coverage of our local cultures.

Teacher B: From the learning outcomes they just state the link between culture and mathematics.....but there are a few examples of them.

Facilitator: Ok, they just mention to make you aware of .....

Teacher B: Yes they just mention that they link but we cannot see how they link.

Teacher B 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 for the materials used in the intervention study visual materials were used. Going through the learning outcomes in the given materials, Teacher B cannot see the link between mathematics and culture but in the study the used teaching materials clearly linked the two.



### **Vignette 5: Indigenisation as an entry point to mathematics education**

Facilitator: How has the students' learning of mathematics been affected by the tasks we used?

Teacher 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.

Facilitator: The next question is almost similar to the preceding one. What effect do you think this pedagogy has on students? More active, more discussions about mathematics, more questioning, more value attached to the mathematics.....?

Teacher B: Yes, the fun thing is that the learners were able to make their own explanations from what they see, they can visualise everything and they can also deduct their explanation from that.

The use of culturally-based activities made learning interesting. TR B claims the more learners enjoy the more they learn. Therefore the use of culturally-based activities positively impacted on the learners' learning. According to TR B, learners were involved in mathematical thinking because they could come up with their own explanations.

### **Vignette 6: Expected learning at professional development meetings**

Facilitator: Do you normally attend professional development meetings or workshops and are these meetings sometimes school-based?

Teacher B: We normally attend these meetings outside our school. And sometimes we meet together, the middle schools and the high schools. In such meetings high schools blame us on the quality of learners which we produce and they have to inherit them from us. They say their results are poor because of us. And also we argue that these learners from their primary, we take them knowing nothing. We cannot start from primary because our work will be behind.

Facilitator: So everyone is like.....

Teacher B: Pointing at one another but no, we cannot point at one another like that, we have to introspect in our own teaching. How do we teach our learners because the most problem is that these children, almost all of them if you give them homework they come back and do the homework in the classroom.

TR B values professional learning communities where there is introspection into real teaching. She wants to learn about how she can teach to improve the participation of her learners. She does not value staff development meetings where participants debate about who to blame in students' failure. To her, professional development should help her to improve in her pedagogical knowledge.

## **DISCUSSION**

In this article teachers' narratives were analysed based on their engagement in a professional learning community. At the beginning of the learning community teachers expressed reservations on implementing the demands of the curriculum reform which expected them to connect learners' cultures in the teaching and learning of mathematics. Their major problem was lack of resources. Teachers had no idea of where they could extract the required ethnomathematics. Teachers got into the community of practice working at the periphery. In communities of practice, learning arises from 'legitimate peripheral participation' (Lave and Wenger, 1991).

However, upon participating on the extraction of the mathematics embedded in cultural activities teachers began to value positively their engagement in the proposed professional learning community. Mutual engagement was evident through the teachers' responses on the extraction of mathematical concepts embedded in the cultural activities. This opportunity indicates the potential for the professional learning communities to develop new and shared understandings, or shared repertoire for the teachers. This is in line with Timmis (2014)'s argument that learning is not just accomplished through interaction but it is constituted within the interaction of the participants. The suggestion of co-teaching was initially met with resistance. Teachers thought they were not going to come with enough resources to enable them to teach. However, I assured them that the planning of lessons was going to be done collaboratively as a team. This sharing of resources and planning together seems to be in line with the research literature on teacher learning which suggests that developing new ways of working is achieved through collaborative acts of meaning making and ways of envisaging this as a mediational tool (Hermansen and Nerland, 2014).

The researchers analysis of the vignettes on the espoused perceived benefits from the PLC envisaged opportunities for the teachers to develop pedagogical content knowledge on connecting learners' cultures to the teaching and learning of mathematics. After every lesson a reflective meeting was held where teachers discussed their current teaching practices and experiences when enacting culturally responsive teaching. According to Stoll and Louis (2007), reflective inquiry provides a through conversation about teachers' teaching and learning. In the meetings, teachers' current experiences on enacting culturally responsive teaching were discussed. Voogt et al. (2015) argued that collaborative learning practices take time, therefore time should be allocated in order to allow teachers to share their ideas and provide opportunities for negotiating between different perspectives and meaning. From Teacher B's narratives there is evidence that she professionally gained from participating from the community of practice. She now

has confidence in connecting mathematics teaching and learning to learners' cultures. The focus on culturally relevant pedagogy brought with it sound pedagogical practices which the participating teachers perceived as bringing some changes in their usual teaching practices. Hertzberg and Roe (2016) noted that teachers learn best when they are involved in the activities that focus on instructions and students' learning in the setting in which they teach.

While international studies suggest that PLCs that are initiated by teachers are more effective than those PLCs that are initiated by the administrators (William, 2007), in this study I argue that the issue of who initiated the TLC is not a determining factor of its functional effectiveness. What is important is the autonomous decision-making regarding what should be learnt and how it should be learnt. In this study the TLC was initiated by the facilitator but teachers gave wide evidence of the perceived benefits. Teachers need time to develop, absorb, discuss and practice knowledge, which implies that activities that effectively result in professional learning need to be sustained and intensive than brief and sporadic. Given the wide evidence of the perceived benefits, I suggest the need for quality professional development on ways of making meaningful connections to learners' cultures in the mathematics classrooms. However, the challenge is: Who will in-service or teach the teachers? Many teacher educators may themselves be in need of similar in-service. They may also face great difficulty with pedagogic competences espoused in the study.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

## REFERENCES

- Adler J (2002). Global and local challenges of teacher development, an investigation of take-up in South Africa. Pretoria: van Schaik.
- Brodie K, Shalem Y, Sapire I, Manson L (2010). Conversations with the mathematics curriculum: Testing and teacher development. Paper presented at the 18<sup>th</sup> Annual Meeting of the Southern African Association for Research in Mathematics, Science and Technology Education, University of KwaZulu-Natal, Durban.
- Brodie K (2014). Learning about learner errors in professional learning communities. *Educational Studies in Mathematics* 85(2):221-239. <https://doi.org/10.1007/s10649-013-9507-1>
- Brodie K, Borko H (2016). Professional Learning Communities in South African Schools and Teacher Education Programmes. HSRC Press: Cape Town.
- Brown JS, Duguid P (1991). Organisational Learning Communities of Practice: Towards a unified view of working, learning and innovation. *Organisational Science* 2(1):40-57.
- Chow AW (2016). Teacher Learning Communities: the landscape of subject leadership. *International Journal of Management* 30(2):287-307.
- Day C, Gu Q (2007). Variations in the conditions for teachers' professional learning and development: sustaining a commitment and effectiveness over a career. *Oxford Review of Education* 33(4):423-443.
- De Beer M (2010). Collaboration recommendation for culturally relevant teaching and development in Higher Education. <http://www.copd.org.za/files/pictures/SUBMISSION-COLLABORATION%20RECOMMENDATION%20FOR%20CULTURALLY%20RELEVANT%20TEACHINGwebsite>
- Desimore LM (2009). Improving Impact Studies Teachers' Professional Development: Toward a better conceptualisation and measures. *Educational Research* 58(3):181-199.
- Department of Basic Education (DoE) (2009) Report of the task team for the review of the implementation of the National Curriculum Statement. Pretoria, South Africa: Government Printer.
- Department of Basic Education (DoE) (2011) National Curriculum Statement Grades R-12, 11 September. South Africa <http://www.education.gov.za>
- Department of Education (DoE) (2002). Revised National Curriculum Statement Grades R-9 (Schools) Policy – Mathematics. Pretoria.
- Elliot R, Kazemi E (2007). Research Mathematics Leader: Investigating the mediation of math knowledge needed for teaching on leaders' collective work in mathematics. In: T Lamberg, LR Wiest (Eds) Proceedings of the annual meeting of the North American Chapter of International Group for Psychology of Mathematics Education. Pp. 819-826.
- Freeman DJ, Porter AC (1989). Do textbooks dictate content of mathematics instruction in elementary schools? *American Educational Research Journal* 26(3):403-421.
- Greeno J, Collins A, Resnick L (1996). Cognition and Learning. In D Berliner, R. Calfee (Eds) Handbook of Psychology. Macmillan, New York pp. 15-46.
- Henze I, Verloop N, van Driel JH (2009). Experienced science teachers' learning in the context of educational innovation. *Journal of Teacher Education* 60(2):184-199.
- Hermansen H, Nerland M (2004). Reworking practice through an AFL project: an analysis of teachers' collaborative engagement with new assessment guidelines. *British Journal Educational Research Journal* 40(1):187-206.
- Hertzberg F, Roe A (2016). Writing in the content areas: Norwegian case study. Department of Teacher Education and School Research. University of Oslo, Norway. Reading and Writing: An Interdisciplinary Journal 29(3):555-576.
- Hiebert J, Gallimore R, Stigler J (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? <http://research/3015/Hiebert.pdf>
- Infanti AA (2011). Teachers' Perceptions of Professionalism and Professional Development: A case study in Greece. *World Journal of Education* 1(1):40-51.
- Koellner K, Jacobs J (2015). Distinguishing models of professional development: The case of an adaptive model's impact on teachers' knowledge instruction, and student achievement. *Journal of Teacher Education* 66(10): 51-67. <https://doi.org/10.1177/0022487114549599>
- Lave J, Wenger E (1991). *Situated Learning; Legitimate peripheral participation*. Cambridge University Press.
- Little JW (1993). Teachers' Professional Development in a climate of Educational Reform National Centre for Restructuring Education, Schools and Teaching Teachers' Colleges. Columbia: Columbia University (No RR91172005).
- Lovett S, Cameron M (2011). Schools as professional learning communities for early-career teachers: how do early-career teachers rate them? *Teacher Development* 15(1):87-104.
- Marchant J, Brodie K (2016). Content knowledge and pedagogical content knowledge conversations. In W Mwakapenda, T Sedumedi, M Makgato (Eds) Proceedings of the 24<sup>th</sup> annual conference of the Southern African association for research in mathematics, science and technology education 1:148-159. Pretoria: SAARMSTE.
- Mearns MA (2006). Conservation of Indigenous Knowledge. Unpublished D. Litt et P thesis. South Africa: University of Johannesburg.
- Merriam SB (2009). *Qualitative Research: A guide to design and implementation*. Francisco, Jessey-Bass Publishers.
- Mosimege M (2012). Mathematical connections and contexts. In D Mogari, A, Mji, UI Ogobonnaya (Eds) Proceedings of the ISTE International Conference: Mathematics, Science and Technology Education, South Africa, UNISA pp. 22-26.
- Putman R, Borko H (2000). What do new views of knowledge and

- thinking have to say about research on teacher learning? *Educational Research* 29(1):4-15.
- Reys R, Reys B, Lapman R (2003). Assessing the impact of standards-based middle grades mathematics materials on student achievement. *Journal for Research in Mathematics Education* 34(1):74-95.
- Stoll L, Louis K (2007). Professional learning communities: Elaborating new approaches. In L Stoll, K. Louis (Eds) *Professional learning communities: Divergence, depth and dilemmas*. Maiden: Open University Press.
- Timmis S (2014). The dialectical potential of Cultural Historical Activity Theory for researching sustainable CSCL practices. *Computer – Supported Collaborative Learning* 9:7-32.
- Timperley A, Wilson A, Fung I (2007). *Teacher Professional Learning Development, Best Evidence Synthesis Iteration (BES)*. New Zealand Ministry of Education. <http://educationcounts.edcentre.govt.nz/goto/Bes>
- Voogt J, Laferreire T, Breulex A, How R, Hickey DT, McKenney S (2015). Collaborative design as a form of professional development. *Instructional science* 4:259-282.
- Wenger E (1998). *Communities of practice: learning, meaning and identity*. Cambridge: Cambridge University Press.
- William D (2007). *Changing Classroom Practices*. *Educational Leadership* pp. 36-42.
- Yin RK (2003). *Case Study Research*. London, England: Sage Publications.