

## **The Role of Mathematics in Cultural Activities: Teachers and learners' perspectives**

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**Abstract:** This article analyses teachers' and learners' perspectives on the role of school mathematics in understanding cultural activities. The qualitative study from which this article emerges worked with three mathematics teachers and their Grade 9 learners from one rural school (situated very close to a cultural village). An attempt to connect mathematics concepts to cultural activities was made. Mathematics and culture are often interconnected, making school mathematics intimately linked to the society in which it is taught. Where connections are applied in mathematics education, the position often taken is using cultural activities as a vehicle into understanding school mathematics. This article focusses on the reverse, which is using school mathematics to understand cultural activities. This will be pursued in some discussions of cultural activities via mathematics, largely based on the notion that the mathematics content learnt in schools should be transferrable for use in learners' daily lives. Based on the analysis of data collected over an extended period of ethnographic and participant classroom observation, I argue that school mathematical knowledge can be used to read and understand cultural practices deeper. Critical pedagogy should be valued as an emerging pedagogic agenda in mathematics education. Also the advanced nature of cultural practices need more advanced mathematical knowledge possibly to respond to the complexity of the practices.

**Keywords:** critical mathematics education, critical pedagogy, cultural activities, ethnomathematics, culturally responsive teaching, teacher practices.

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### **I. INTRODUCTION**

Mathematical empowerment concerns the gaining of power over the language, skills and practices of using and applying mathematics. Social empowerment through mathematics concerns the ability to use mathematics for social betterment. The South African National Curriculum Statement (NCS) advocates for the use of mathematics to enable individuals to participate more fully in society through critical mathematical citizenship. Epistemological empowerment concerns the individual's growth of confidence and personal power over the use, creation and validation of knowledge (Ernest, 2004).

In South Africa, education and curriculum have an important role to play in establishing a society based on democratic values, social justice and fundamental human rights (National Curriculum Statement Grades R-12, DoE, 2011a). Mathematics education is not spared from this democratic and social role. The teaching and learning of Mathematics aims to develop a **critical** awareness of how mathematical relationships are used in social, environmental, cultural and economic relations (Curriculum and Assessment Policy Statement Mathematics Grades 7-9, DoE, 2011b). Relationships, hence connections, are an underlying principle of mathematics education.

Studies which advocate for the use of out of school mathematical practices in mathematics education (ethnomathematics as a teaching tool) highlight the necessity and benefits of such connections in bridging academic and cultural mathematics (e.g. Rosa & Orey, 2009; Adam, 2002; Arismendi-Pardi, 2001). Rosa and Orey (2009) explored the symmetrical patterns found in quilts, making connections between mathematics and the craft and art of quilting. Through analysing different symmetrical freedom quilts, Rosa and Orey designed a module for teaching transformations. The module covers detailed work on reflections, translations and rotations captured in lesson plans which can allow teachers to develop classroom activities that help learners to understand geometry, especially concepts of symmetry and transformations. "Geometry concepts, when standing alone, can be seen as abstract concepts for learners, but by analysing actual symmetrical freedom quilt patterns and being surrounded by examples, learners are able to see their relevance to the study of geometry" (Rosa & Orey, 2009, p.23). In general, quilts provide "real world" examples of geometry concepts because they often use translations, reflections, rotations and symmetry. Their study demonstrates how connections can be made between academic mathematics and learners' personal lives and cultures.

Adam (2002) investigated the implementation of an ethnomathematical unit in mathematics classrooms at two primary schools in the Maldives involving Grade 5 teachers and learners. The designed unit was on measurement (area, perimeter, volume) and was implemented in Grade 5 classrooms. Sites such as carpentry, boat building sheds, and markets were visited to explore mathematical aspects of these activities. The reaction of teachers and learners indicated that the ethnomathematical approach appeared to be welcomed, appreciated, and understood by both teachers and learners. "Teachers and students were able to identify activities and experiences in Maldivian culture exhibiting measurement systems, and were able to link this to the conventional mathematics that is part of Grade 5 measurement syllabus" (Adam, 2002, p. 7). The study provides empirically based data to support the claim that ethnomathematics is a possible way of learning mathematics.

Most studies which motivate for the incorporation of ethnomathematics as a teaching tool in the mathematics classrooms argue that ethnomathematical approaches to mathematics curriculum are intended to make mathematics more relevant and meaningful for learners promoting the overall quality of their mathematics learning. Little is known or established about the reverse process that is using school mathematics to deepen understanding of the cultural activities, and hence the article. This article intends to address the question: To what extent can school mathematics be used to understand cultural activities?

## II. CONTEXTUAL PROFILE OF THE RESEARCH SCHOOL

The middle school involved in the study is located in a rural area about 40km from the nearest town in the North West Province of South Africa. At the time of visit the school had 548 registered learners (from Grade 7 to 9). Most learners were from poor family backgrounds with many learners being orphans supported by government social grants. According to the school principal, the prevailing poor socio-economic background was exacerbated by the HIV/AIDS pandemic. Some learners came from child-headed families and others were staying with grandparents. Two research participating teachers reiterated that this posed a challenge to the teaching and learning of mathematics since their home environments were not conducive for school work. Learners were not getting assistance at home.

The school is situated very close to a cultural village; approximately 800m (see Figure 1). This cultural village showcases the cultural diversity that populates South Africa. There are six cultures that are represented at the village vis- a- viz Tswana, Ndebele, Venda, Tsonga, Zulu and Xhosa. According to the school principal, although the school community is multicultural, the dominant culture is Tswana. The workers at the cultural village are able to showcase various indigenous activities appropriately in their historical and socio-cultural background. The cultural village therefore acts as an avenue for elderly and traditional educators/ practitioners to pass their knowledge and skills generationally. The proximity of the school to the cultural village provides opportunities for both teachers and learners to learn about the indigenous knowledge systems of the local cultures. Mosimege (2004) argued that cultural villages could serve more educational purposes than being mere tourist centres.

In Figure 1 below, the thatched huts appearing on the top right hand corner are the structures at the cultural village.



**Figure 1:** The school site in relation to the cultural village

According to the participating teachers, learners who participated at the cultural village were mainly doing so for a living. They sometimes participated at shopping malls where well-wishers often gave them money and food. Does the mathematics learners acquire at the school help them to be better participants at the cultural villages? Are learners apprenticed to be conveyers of mathematical knowledge during the teaching and learning of mathematics? The learners who participate at the cultural village therefore need mathematical knowledge for survival. In this article I argued for the need for teachers to embrace, implement and share ideas that promote critical mathematical pedagogy centring mathematics instruction specifically around issues of social reform (Skovsmose, 1994). The article first establishes the need for critical mathematics pedagogy in mathematics classrooms. However, there is literature which argues that this pedagogy is faced with some implementation problems. The implementation problems are then discussed in the article.

### **III. THE CRITICAL MATHEMATICS CLASSROOM**

The goal of the critical mathematics education is to empower students with knowledge, skill and dispositions needed to create democratic communities embracing social justice in and outside of school (Tutak et al, 2010). According to Wright (2014), mathematics has been taught using a combination of methods based on teaching algorithms, formulae and abstract exercises from a range of textbooks. These methods of teaching mathematics do not allow students to connect the mathematical concepts being taught with their personal interests, backgrounds or real life experiences (Osler, 2007a). Voss and Rickards (2016) suggest that when mathematics is taught using a social justice pedagogy, both student learning and engagement with real world improve making students more self-directed as learners throughout the course of the study. Gutstein (2006) also argues that if students are unable to connect mathematical content with their own lives, they can obtain a false perception of the essence, value and power of mathematics in everyday work and life. Critical mathematics education enables students to read the world with mathematics (Tutak et al, 2010).

For the learners in the study if mathematical knowledge can be used as a tool for improving their participation in the cultural activities, it is therefore used for social and economic empowerment since the learners participate for a remuneration. Social empowerment through mathematics concerns the ability to use mathematics for social betterment. Hence the critical mathematics classroom establishes mathematics as an essential tool for understanding and changing the world. It connects mathematics with learners' cultural and community histories, while in turn, motivating learners to engage in learning significant mathematics (Stinson, Bothwell & Powell, 2012).

Bartolomé (1996), delving into conceptualising critical pedagogy, argues that it is a humanizing pedagogy that values learners' background knowledge, culture, and lived experiences, moving learners into their own ever-expanding interpretations of their lived worlds (Greene, 1996). Critical mathematics pedagogy is most often framed as teaching mathematics for social justice (Stinson, et.al, 2012). Gutstein's (2006) social justice pedagogical goals in mathematics education are; reading the world with mathematics, writing the world with mathematics and developing cultural and social identities. From this observation I argue that school mathematics can be used to interpret and understand cultural activities.

### **IV. IMPLEMENTATION PROBLEMS**

Although these new understandings of mathematics teaching and learning may sound very appropriate, the implementation and impact of explicit instructional strategy may not be widespread and unproblematic. The major challenge has been how to convert this vision of teaching mathematics for social justice from the written curriculum into the taught curriculum. In South Africa, teaching in schools rarely grounds mathematics instruction in learners' cultures and communities (Mosimege, 2012), it rarely brings the interconnection between mathematics and culture in pedagogically informed ways. In his plenary address on 'Mathematical connections and contexts' at the Institute for Science and Technology Education (ISTE) 2012 International Conference at Kruger National Park in South Africa, Professor Mosimege (ibid) reiterated that mathematics teachers lack the ability to make connections in their mathematics classrooms; their indigenous (local) content knowledge is shallow. Also, an evaluation of the implementation of the NCS carried out in 2009 by the Task Team for the Review of the implementation of the National Curriculum Statement revealed that some teachers had problems of converting the NCS vision of mathematics teaching from the written into the taught curriculum. Some teachers face challenges when using social/cultural contexts to reveal the underlying mathematics while simultaneously using the mathematics to make sense of the contexts themselves. In so doing they are hindered from developing in their learners the ability to read and understand their world mathematically. It is from the above observations that I saw a need for engaging in a deeper exploration of how mathematics and culture connect at classroom level. I engaged with mathematics teachers in a school-based professional learning community. The key aim of the professional development was to create critical mathematics classrooms, using out-of-school, culturally-based activities.

## V. METHODOLOGY

The study (from which this article emerges) with its focus on critical theory and constructivism paradigms needed hermeneutic methods seen as involving dialogue with participants as sources of information. We then relied on qualitative data using a case study approach or style of inquiry in search of understanding the extent to which school mathematics could be used to understand cultural activities. The study linked the mathematical knowledge being taught in a school (close to a cultural village) to the knowledge and activities of the cultural village<sup>1</sup> itself, interrogating connections between mathematics and indigenous knowledge systems. Apart from enabling learners to access and understand school mathematics, I also hoped this would equip the participating teachers and their learners with personal power over the creation and validation of knowledge (epistemological empowerment). Where applicable, I also hoped to equip the participants with the power and ability to apply their school mathematical knowledge in participating in and understanding cultural activities. This article raises the question of the extent to which school mathematics can be used to understand cultural activities. This, I argue, has a bearing on the teaching and learning of mathematics where mathematical connections enable the recognition and application of school mathematics to contexts outside of mathematics - the links between mathematics and other disciplines or the real world (Blum et.al, 2007).

Contexts are useful insofar as they provide access to school mathematics. However, learners' ability to make connections in mathematics itself is crucial for conceptual understanding (Antony & Walshaw, 2009) as well as for application outside the discipline. This article focuses on using school mathematics to deepen our understanding of cultural activities, largely based on the position that the mathematics content learnt in schools should be transferrable to learners' daily lives. This view considers mathematics as relevant and practical. Mathematics has a utilitarian value and can be applied to many aspects of everyday life. From this orientation, teachers play a crucial role; they must teach lessons in ways that will enable learners to recognise and make sense of these mathematical connections (Mhlolo, Venkat, & Schäfer, 2012)

### **Data collection procedure**

Videos of the cultural activities were recorded. Learners who participated in cultural dances performed at the cultural village<sup>1</sup> were asked to demonstrate a cultural dance during a mathematics lesson. The dance was analysed mathematically, that is mathematical ideas being applied in the dance were extracted. The extracted ideas led to the formulation of a number pattern. The rule for getting terms of the formed sequence was discussed. Besides enabling learners to access mathematics through the dance, school mathematics was used to understand the dance deeper through linking the dancing style to a number pattern.

Video recorded cultural activities and cultural artefacts from the cultural village were analysed by the researcher and the three mathematics teachers who were participating in the research. Embedded mathematical ideas were extracted from the activities. School mathematical knowledge was used to interpret the activities. From the extracted mathematical ideas, a teaching and learning unit was designed and implemented in five Grade 9 classes. Artefacts from the cultural village were used to enact critical pedagogy in the mathematics classrooms. All in all, seventeen mathematics lessons were taught. The lessons were co-planned and co-taught by the researcher and the class teachers. Learners were asked to complete lesson journals after every lesson (approximately 600 journals were analysed). Lesson reflective meetings were held with the teachers. Teachers were pre and post interviewed individually. All the interviews were semi-structured to allow the exploration to create meaning-making through open-ended questions. The open-ended questions allowed flexibility to pursue responses that were relevant but initially not expected.

Learners were interviewed and asked to complete a questionnaire after the intervention teaching. This was aimed at understanding the impact which the critical mathematics pedagogy used in the study had on learners. This enabled me to explore learners' views about the use of cultural contexts in mathematics education. In the questionnaire learners were asked to state what they liked about the way they learnt the topics taught in the culturally-based lessons. I designed a learners' journal entry to allow learners to describe the lessons where culturally-based activities were summoned. The major concern was to determine what learners foregrounded in their lesson descriptions. In the classroom environment, learning something new or different and then reflecting on what that means may reflect an important learning outcome. For this article, I basically checked for statements suggesting the use of mathematics to understand cultural activities.

### **Data analysis**

Excerpts from learners' narratives, teachers' interview transcripts and comments on reflective meetings were analysed in order to describe the participants' perspectives on the use of mathematics in understanding

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<sup>1</sup> A cultural village is a tourist establishment where tourists can view aspects such as the homestead, traditional clothing, food and foodrelated practices, history and societal structures as well as song and dance routines of one or more of South Africa's cultures (Mearns & du Toit, 2008).

cultural activities. Also the researcher's observational data from cultural activities was used to determine the extent to which one can successfully model (mathematically) cultural activities.

To begin the analysis of learners' data, completed questionnaires were given identity codes that represent the type of questionnaire, the class of the learner and the number of the questionnaire. This was also applied to the learners' journals. For example a questionnaire completed by a learner in Grade 9A was identified as Q1LA01, Q1 denoting first questionnaire and Q2 denoting the final questionnaire, LA denoting learner from Grade 9A, and 01 denoting the number of the questionnaire. For J1LA01, J1; J2; and J3 denote Lesson Journal 1, 2 and 3 respectively and LA01 with the same representation as above. For G1LA01, GI denote group interview.

In the sections that follow, I present the results of the analysis that captures the following aspects:

- Participating teachers' perspectives on the connection between school mathematical knowledge and cultural activities.
- Learners' perspectives on the connection between school mathematical knowledge and cultural activities.

The article then examines issues related to the analysis and concludes that the extent to which one can use mathematical knowledge to understand cultural activities depends on one's level of mathematical, social and epistemological empowerment and awareness of this empowerment.

## **VI. PARTICIPATING TEACHERS' PERSPECTIVES ON THE CONNECTION BETWEEN SCHOOL MATHEMATICAL KNOWLEDGE AND CULTURAL ACTIVITIES**

Before the collaborative implementation of critical pedagogy in their mathematics classrooms teachers reiterated that they were familiar with the activities at the cultural village. (TR A = Teacher A; TR B = Teacher B; TR C = Teacher C). TR A was teaching one Grade 5 class and TR B and TR C were both teaching two classes each.

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.

It is clear from the above that teachers indicated familiarity of cultural activities. However, were the teachers and learners also aware of the possible use of mathematics in the cultural activities? In the first meeting teachers indicated that they were familiar with the activities at the cultural village. However, at the conclusion of the study, they contended that the way they were now going to see these activities was completely different.

R: Do you think the way we used activities at the cultural village will shift the way you will see these activities the next time you visit the cultural village?

TR A: Definitely sure because now I will be very observant to understand activities using mathematics. Since I now know their paintings contain a lot of mathematical ideas, some I observed in the lessons. I will also try to be very observant and look for some more mathematical ideas to integrate in my teaching.

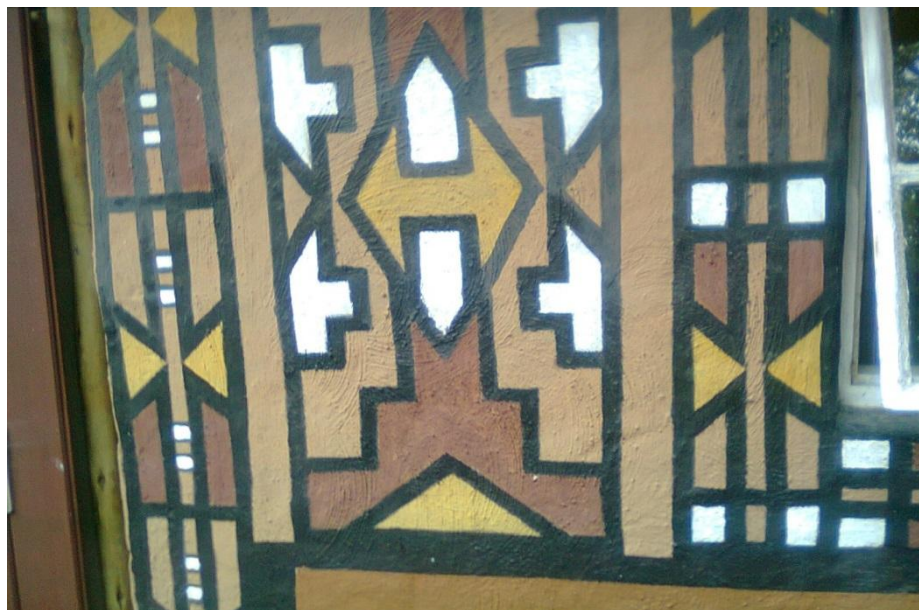
TR B: Yes now we are going to see activities differently, because we are now going to see different kinds of shapes, number patterns, different colours and how they are used to create patterns and all these are included into mathematics and can be incorporated when teaching.

When commenting on one of the lessons TR C made the following comments:

TR C: Learners were able to identify different shapes (mathematical shapes) from paintings used by different cultures e.g. Ndebele. They had a constructive debate in groups when identifying the involved types of transformations. Learners showed understanding. They participated well in the lesson. I liked that learners were able to discover that the mathematical skill - transformations is also applied in our cultural activities, meaning they can use transformations to study the paintings at the village. Ndebele people use mathematical patterns, lines, shapes, reflections, translations to design their houses.

The above statements by teachers suggest a new way of seeing and understanding cultural activities, thus seeing them with a mathematical lens. In the past although the teachers emphasised that they knew activities taking place at the cultural village, knowing them and understanding them now appear to be two different things. The use of mathematical knowledge adds more appreciation of the cultural activities. TR B emphasised that she was going to appreciate the decorations and the colours through using her mathematical knowledge, thus reading the cultural activities with mathematics. This sends a message that one's mathematical knowledge can assist him/her to read and understand cultural activities that is, reading the world with mathematics (Gutstein, 2006). The deeper the mathematical knowledge one has, the deeper he or she will get to understand the cultural activities. For example knowledge of bounded sequences was (in the study) used (by the authors) to understand the need for limiting the number of dancers in each dance. According to TR C the knowledge of properties of shapes and different transformations can be used to read and understand the decorations on Ndebele paintings and beadings and Venda traditional clothes. For example, from the pictures below learners can identify shapes which represent different transformations. This may lead to the deeper understanding of the paintings and beadings.





**Figure 2:** Ndebele paintings



**Figure 3:** Ndebele beadings

All the three teachers reiterated that learners can use their mathematical knowledge to increase their participation at the cultural village. Also learners can create self-employment after school through designing Venda traditional materials applying their mathematical knowledge of shapes and transformations. Hence mathematical knowledge can be used to boost economic empowerment.

## **VII. LEARNERS' PERSPECTIVES ON THE CONNECTION BETWEEN SCHOOL MATHEMATICAL KNOWLEDGE AND CULTURAL ACTIVITIES**

Learners also evaluated their knowledge of school mathematics as enabling them to understand cultural activities better. This is illuminated in some of the learners' remarks below: (All the underlining was done by the authors to add emphasis)

Q2LC26: I feel good because I have learnt how mathematics can be used to change the rhythm of the dance. I now understand the Tswana dance better than before.

J1LD02: I now know how to dance and how to draw a number pattern from a dance. I understood mathematics from that dance. I understand how mathematics and traditional dance work.

J1LA16: We watched the Tswana dance checking their steps so that we can understand what they are doing when they dance.

Q2LC08: I got interested because when we go to the cultural village we can learn more about number patterns.

Q2LA05: Mathematics has very important applications outside of class which can help you to understand the subject and the activities. All you need to do is to talk about maths in front of others if you don't talk you will find it hard to know mathematics.

LB3GI: I think much has changed because I used to see cultural activities as activities which just ended at the village but now...now I can use the activities to understand the mathematics we learn at school, to simplify my work and also use mathematics to understand these activities.

LE3GI: When I go to the cultural village I will focus on finding the mathematics they will be using. I think I will spend more time trying to find that mathematics.

GILB01: I used to participate in dancing only at the cultural village. I now want to join the weavers. I know I am going to produce beautiful beads applying my mathematical knowledge on shapes and transformations. I will sell the beads to raise money for food.

GILA05: After my Grade 12 I will look for apprenticeship at the cultural village where I will learn how to produce cultural artefacts for sale.

According to Q2LC26 his/her mathematical knowledge helped him or her to read the dance and learn more about the traditional dance. Q2LC26's comment also illustrates the power of mathematics: "mathematics can be used to change the rhythm of the dance". Thus suggesting that the more mathematics one knows the more one can understand the cultural activities. JILD02's comment (I now know how to dance) in the excerpt indicates competence and confidence gained as a result of participation in the mathematics community of practice. Learners such as JILD02, who access mathematics through authentic cultural contexts, become doubly advantaged in that they gain access to both mathematics and practical aspects of the recruited context itself.

The learners (e.g. LB3G1 and LE3G1) seem to be suggesting that the research activities developed in them a skill to read the world mathematically, which they thought they would use when they visit the cultural village in future. Learners valued and appreciated the gained knowledge which would enable them to understand and experience cultural activities from a mathematical point of view. Their participation in the study equipped them with a mathematical lens which they said they were going to use to view and read the world mathematically.

Learners GILB01 and GILA05 are already seeing an employment window through participating in cultural activities applying mathematical knowledge. They now see mathematical knowledge as giving them an urge over others. GILB01's comment, *I know I am going to produce beautiful beads applying my mathematical knowledge on shapes and transformations*, indicates the learner's confidence in the application of mathematical knowledge in making cultural artefacts.

## VIII. DISCUSSION

My data analysis highlights some benefits of engaging critical pedagogy in mathematics classroom. In order to induct learners into thinking mathematically and viewing the world through mathematical lenses, mathematics pedagogy should explore contexts/scenarios to both deepen understanding of mathematics and understanding of the contexts/scenarios involved (Stinson et al., 2012).

Throughout the aforementioned narratives, the participating teachers articulate connections between school mathematics and cultural activities. TR C reiterated that learners could use knowledge on transformations to read and understand cultural paintings at the cultural village. "I liked that learners were able to discover that the mathematical skill – transformations is also applied in our cultural activities, meaning they can use transformations to study paintings at the village". These remarks by TR C suggest that learning can be transferred from one context to another. However, I am aware that from the situated cognition perspective, transfer of knowledge from one context to another is not unproblematic (Lave, 1988). 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; Bossard et al., 2008). TR A and TR B articulated their participation in the study as developing a new way of looking at cultural activities, rather than learning a mere method of teaching. They indicated that they were going to use their mathematical knowledge to read and understand activities at the cultural village. "I will be very observant to understand activities using mathematics" (TR A). In their remarks, knowledge of the subject matter – in this case, mathematics is to be used to examine and make better sense of the lived worlds (Gutstein, 2006).

Culturally-based lessons encouraged learners to recognise hidden ways in which school mathematics is used within everyday life (epistemological empowerment). LB3GI reiterated, "I used to see cultural activities as activities which just ended at the village but now...now I can use the activities to understand the mathematics we learn at school (mathematical empowerment), and also use mathematics to understand these activities" (social empowerment). GILA05 emphasised, "After my Grade 12 I will look for apprenticeship at the cultural village where I will learn how to produce cultural artefacts for sale" (economic empowerment), learners become more aware that they are using mathematics more than they previously recognised, learners may determine that they know more mathematics than they had thought (Frankstein, 1990). Learners in the study, after recognising the ways that school mathematics is being used in the cultural activities, they became more confident in their mathematical understanding and understanding of the cultural activities. This is illuminated by the following remarks.

Q2LA05: Mathematics has very important applications outside of class which can help you to understand the subject and the activities. All you need to do is to talk about maths in front of others. If you don't talk you will find it hard to know mathematics.

The underlined phrase in the above excerpt indicates the importance of talk – talk is providing entry to mathematics education. It also indicates the need for dialogue in critical mathematics pedagogy. The dialogical educator creates pedagogical spaces for epistemological curiosity where learners become apprentices in the rigors of exploration (Freire & Macelo, 1996).

The connection between learners' own lives and the school mathematics content may allow learners to develop a stronger mathematical identity (Leonard et al., 2010). As Ladson-Billings (1997) points out, it is not necessary to mathematise every topic but instead to allow learners to see, compare, and evaluate the link between the real world and mathematics. This, I argue, will assist learners to understand both the mathematics more and the real world. Through being able to describe, analyse and understand the world with mathematics, learners may see their everyday lives in a way they would have never anticipated. This helps learners to realise that mathematics can be used as a tool in society (Gutstein, 2003). From the identified learners' narratives in the context, "read the world with mathematics" (Gutstein, 2006), learners stepped out of the culturally-based lessons with a new outlook on how mathematics can be an effective tool in their lives – viewing mathematics as a tool to understand the world in which they live. And also valuing mathematical knowledge as providing a pathway for raising money.

My experience in the study revealed that learners need to be apprenticed into ways of investigating mathematics and to be 'conveyors' of school mathematical knowledge. Therefore educators should make meaningful connections to learners' cultures in their mathematics classrooms. However, teaching in schools rarely brings the interconnection between mathematics and culture in pedagogically informed ways. The participating teachers, before the implementation of critical mathematics pedagogy, indicated they were not making connections to learners' cultures due to lack of the required cultural mathematical content knowledge. This suggests the need for quality professional development on ways of making explicit connections to learners' cultures in mathematics classrooms. 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 as espoused in this study.

Also my participation in the study revealed that successful mathematisation of cultural activities required adequate and relevant mathematical content knowledge. As the activities become more and more advanced and complex, more advanced mathematical knowledge is also needed to respond to the complexity of the practice. Limited mathematical content knowledge limits the intricate and flexible use of school mathematics to read and understand the cultural activities. More successful modelling also depends on one's level of mathematical empowerment and awareness of this empowerment.

## IX. CONCLUSION

The focus of critical mathematics pedagogy for social empowerment brought with it sound pedagogical practices which participating teachers and learners perceived as empowering them into ways of reading mathematics and understanding cultural activities with mathematical lenses. If mathematics education continues to fail to connect mathematics to learners' cultures, it will continue to fail to socially empower learners (and teachers) into ways of examining real-life activities. Therefore, in order to best address these pitfalls and create individuals which most intended mathematics curricula claim to be producing, teachers need to embrace, implement and share ideas that promote critical pedagogy. Does one need the social phenomena first in order to produce/create, learn or apply mathematics? In this article the participating teachers and their learners seem to be putting forward that one might need mathematics first in order to be able to identify/create it in/for given social phenomena. By so doing it will help that individual to read and understand the social phenomena deeper.

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