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From the Cultural Village to the Classroom and Vice-Versa: Transfer of Learning in Mathematics

By

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Abstract
This article analyses the possibility of transferring mathematical knowledge from a cultural context to a school context and vice versa. The study was anchored on psychological theories regarding transfer of learning. An attempt to connect mathematics concepts to cultural activities was made, interrogating the possibility of transfer of learning. This was pursued in some discussions of cultural activities via mathematics, largely based on the notion that the mathematics being applied in cultural activities could be used as a vehicle to accesses academic mathematics. The study also explored the extent to which the mathematics content learnt in schools could be transferrable for use in the learners' daily lives. The study was qualitative in nature and it employed the ethnographic research design. A large sample of three mathematics teachers and their 218 Grade 9 learners from one rural school situated very close to a cultural village in the North West Province of South Africa took part in the study. Questionnaires and interviews together with video recording were used to collect data during the empirical investigation. Based on the analysis of data collected over an extended period of ethnographic and participant classroom observation, the study established that school mathematical knowledge can be transferred from one context to another basing on the theory of identical elements which is anchored on the premise that the extent to which knowledge and skills acquired in learning one task can assist an individual to learn another task hinges upon the extent of the similarity between the two tasks.

Key words: cultural activities, mathematical knowledge, transfer of knowledge, mathematisation and cultural artefacts

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Introduction and background to the study

One of the fundamental duties of classroom practitioners is to impart knowledge, skills and attitudes on learners or students so that the candidates can subsequently apply the learnt concepts or skills in a myriad of situations in and outside the classroom context (Santrock, 2004). Mwamwenda (2010) posits that if what is learnt in educational institutions was to remain there, then there would be no justification for schools and neither would there be any need for classroom practitioners at various educational tiers. This phenomenon brings in the issue of transfer of learning. Learning in general refers to the relatively permanent change in behaviour, attitudes or skills as a result of experience (Feldman, 2009). According to Mangal (2002) transfer of leaning is a situation whereby learning or training in one situation influences learning or performance in some other situations.

Santrock (2004: 304) views transfer of learning as a situation in which an individual applies previous experiences and knowledge to learning or problem solving in a novel context. Snowman, McCown and Biehler (2009:259) posit that transfer of learning is a situation where the existing established habits has an influence on the acquisition, performance or re-learning of a second task. The extent to which learners can implement what they have learned in education institutions in real life situations has been explored in numerous academic disciplines including Mathematics. The current study examines the extent to which mathematical knowledge learnt outside the school can be transferred to enhance learners' ability to apply and learn mathematical concepts. Mathematics learnt in schools can also enhance learners' ability to participate in cultural activities. As part of the background to the study, some types and theories of transfer of learning were outlined together with the utility of Mathematics as an academic discipline.

Transfer of learning can be divided into positive, negative and neutral transfer. According to Snowman, et al (2009: 259) positive transfer is a situation whereby prior learning facilitates subsequent learning. Mwamwenda (2010) reiterates that positive transfer occurs when what is learned in one situation positively influences what is learned in another situation. On the other hand, negative transfer refers to a situation whereby a learnt skill or concept interferes with an individual's attempt to learn in a new situation (Santrock, 2004). Zero transfer occurs when what has previously been learned does not influence new learning in any way. It is worth noting that zero transfer can also mean a learner's inability to apply what they have learned to new situations (Mwamwenda, 2010).

Numerous theories have been advanced in an endeavour to articulate how transfer of learning occurs. In the current study, three theories of transfer of learning are briefly outlined. These include the theory of mental discipline, the theory of identical elements and the theory of generalisation. The doctrine of mental discipline, which is also called the doctrine of formal discipline, was popular in the 1900s and it claimed that people's ability to memorise, learn, reason and transfer information could be improved by studying intricate subjects such as Latin, Greek and Geometry. Snowman, et al (2009:259) explains, "The rationale behind this practice was that the human mind, much like any muscle in the body, could be exercised and made stronger. A strong mind would learn things that a weak mind would not". However, the doctrine of formal discipline was ultimately found to be erroneous and was therefore subsequently relegated to disuse and

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obsolescence. The correct position was that people who were intellectually endowed pursued difficult subjects because they liked them, not for the sake of having their minds sharpened.

Edward Lee Thorndike, a behavioural psychologist who made significant contributions to education, developed the theory of identical elements in 1901 to explain how transfer of learning occurs. In simple terms, Thorndike's theory of identical elements (Snowman, et al, 2009; Mwamwenda, 2010). Charles Judd's developed the theory of generalisation to explain how transfer of learning takes place. Generalisation is a principle of behaviourism in an organism as it learns to respond in a certain way to stimuli which are similar to the circumstances or stimulus under which the initial learning occurred (Lahey, 2009: Feldman, 2009). This implies that the extent of transfer depends on the extent to which experiences in the first situation are understood and consolidated into generalisation.

According to Awolola (2011:91) and Kufakunesu (2015) Mathematics is generally rated as a crucial academic discipline because of its utility in the technological, industrial and economic advancement of any country. Githua (2013:174) and Mbugua, Kibet, Muthaa and Nkonke (2012:87) reiterate that Mathematics mostly acts as a foundation of scientific and technological concepts which are needed by practically all nations for their socio-economic progress. The same sentiments were echoed by Mahanta and Islam (2012:713) and Nziramasanga (1999:323) who maintain that Mathematics is a vital leaning discipline which is useful in solving real life existential problems. It has also been argued that apart from being a pivotal foundation for lifelong learning, Mathematics makes young people better equipped to meet the numeracy demands of many modern workplaces (Kufakunesu, 2015; Lamb & Fullarton, 2001:3). Nyaumwe (2006:40) together with Tachie and Chireshe (2013:67) maintain that the utilitarian values of Mathematics such as its role in opening career avenues for learners make Mathematics a very crucial academic discipline in the curriculum of any country. In many countries, elementary Mathematics is prerequisite for science, computer science and engineering diploma and degree programmes. Given the importance of Mathematics as outlined above, it is arguably necessary for a study pertaining to some variables which relate to Mathematics achievement to be undertaken in the hope of generating research findings which can enhance the quality of Mathematics teaching and learning in Zimbabwe and beyond (Tachie & Chireshe, 2013:67; Kufakunesu, 2015). After considering these views, the researchers deemed it necessary to focus on the concept of transfer of learning with Mathematics as the discipline under consideration.

Lev Vygotsky was a Russian psychologist who posthumously rose to prominent in educational circles because of his sociocultural theory in which he articulated how cognitive development occurs (Lahey, 2009). Vygotsky's sociocultural theory has a number of principles which entail the role of social interaction, culture and language in cognitive development. Moreover, the sociocultural theory entails principles such as scaffolding, the zone of proximal development and play as mechanisms which facilitate and espouse cognitive development. In the current study, the principle of culture was employed in examining how culturally learnt activities can be instrumental in enhancing transfer of learning in Mathematics. Culture can be viewed as totality of the various ways people in a certain province or country or even continent interact and function (Donald, Lazarus & Lolwana, 2010). This implies that culture entails language, traditional practices such as dances, ceremonies and procedures which a particular group of people employ as they navigate the various existential contexts. Numerous studies including Vygotsky's sociocultural theories have postulated and generated empirical evidence to back the notion that that culture has a bearing on learners' intellectual development and functioning (Feldman, 2009; Mwamwenda, 2010).

A brief look at the developmental stage of the research participants involved can add an extra dimension regarding the relevance of transfer of learning in a mathematics context. The high

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school learners who participated in the various cultural activities in an established cultural home were adolescents by virtue of being high school learners. By definition, adolescence is a developmental stage in which individuals a change from childhood to adulthood (Lahey, 2009). It has to be acknowledged that the transition from childhood to adulthood is a volatile experience characterised by mood swings, elevated interest in members of the opposite sex, emotional turbulence and the quest for an identity (Mwamwenda, 2010; Santrock, 2004). Moreover, adolescents are characteristically energetic but poised towards being rebellious to any form of authority (Feldman, 2009). In the examined context, participation in the various activities lined up at the cultural village enhanced the high learners' identity formation (Kufakunesu, 2015). Furthermore, the numerous cultural village activities gave the respondents the opportunity to mingle across the gender divide thereby fostering emotional satisfaction on the part of the adolescents. The current study further explored how participation in the cultural village activities could foster transfer of Mathematics on the part of the adolescent high school learners in South Africa.

Statement of the Problem

Thorndike's (1901) theory of identical elements is anchored on the premise that the extent to which knowledge and skills acquired in learning one task can assist an individual to learn another task hinge upon the extent of the similarity between the two tasks. However, learners may have the knowledge that is not activated. The current study explored the possibity of transferring mathematical knowledge from a cultural context to the classroom and vice-versa.

Methodology

The empirical investigation which generated data for use in the current study 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 and vice versa. Thus, understanding how cultural activities can enhance access of academic mathematics.

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 itself, interrogating the possibilities of transfer of knowledge. The article raises the question of the extent to which mathematical knowledge learnt outside the school can be transferred to understand/access academic mathematics. It also raises the question of the extent to which school mathematics can be transferred to understand cultural activities. This we argue has a bearing on the recognition of contexts outside school where mathematical knowledge is being used and the connection of such mathematical knowledge to academic mathematics.

In literature there is a predominant focus on connections targeted at using cultural mathematics to understand academic mathematics. Contexts are useful in so far as they provide access to academic mathematics. However, learners' ability to make connections in mathematics itself is crucial for conceptual understanding (Antony & Walshaw, 2009). Haskell (2001) argued that one of the central purposes of education is to be able to apply what we have learnt in different contexts and to recognise and extend that learning to completely new situations, thus knowledge transfer.

Samples and Sampling Procedures

The sample in this 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 (218 learners in all), cultural dancers (these included some of the 218 learners) and the trainer of cultural dancers. A cultural village was identified as the research site and mathematics teachers who teach at a school very close

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to the selected cultural village were invited to participate. A cultural village was selected with the belief that it is where the community's indigenous knowledge is preserved. It was further considered that activities at a cultural village could assist teachers and learners in the teaching and learning of mathematics through mathematising the activities and transferring knowledge. 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. A school close to the cultural village was chosen with an assumption that its members (including learners) could be quite familiar with the activities taking place at the cultural village. This assumption was supported by the school principal's comment that they were using the cultural village in Arts and Culture activities and that some learners were participants of activities at the cultural village.

Data Collection Procedure

Videos of the cultural activities were recorded. The performers of cultural activities and the trainer of cultural dancers were interviewed to check on the extent to which they were using mathematics in understanding the cultural activities. A group of Grade 9 learners demonstrated a Setswana step dance, a cultural dance practiced at a cultural village near the school. The dancing style was mathematically modelled. The mathematical knowledge being used in the dance was documented.

Some artefacts collected from the cultural village were also 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 first author and the class teachers. 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 interrogating the possibility of transfer of knowledge from one context to another. This enabled us 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. We 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 connection with transfer of learning. The trainer of cultural dances who also happened to be the cultural village manager was interviewed to check on how he valued the impact of academic mathematical knowledge in understanding cultural activities. For this article, we basically checked for statements suggesting the transfer of mathematical knowledge from one context to another. Due to the nature of case studies, one cannot generalise the findings beyond the studied case. However, consistent with the objective of the study, the findings could lay principles for making high quality mathematical connections and transfer of learning in practice.

Research Findings and Discussion

Mathematisation of a cultural dance

To begin the analysis, 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 student identification number. For J1LA01, J1;

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J2; and J3 denote Lesson Journal 1, 2 and 3 respectively and LA01 with the same representation as above. For GILA01, GI denote group interview.

Learners who participated as dancers at the nearby cultural village were asked to demonstrate a cultural dance in class during a mathematics lesson. The dancers had a leeway to showcase a dance of their own choice but were told to present it in about five minutes. The picture below shows some learners demonstrating a Tswana dance during a mathematics lesson.

Figure 1: Demonstration of a Tswana dance

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-steps made in one direction before change of direction (see **table 1** below).

Table 1:

Number of dancers	1	2	3	4 - - - -	n
Number of foot-steps	5	10	15	20 - - - -	nx5

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, and making ‘n’ too large meant too many dancers dancing at the same time making it difficult to follow the dancing style. At higher levels the depicted scenario can be used to introduce bounded sequences. This therefore means the knowledge of bounded sequences may be used to understand the need to limit the number of dancers to a minimum and maximum number of dancers.

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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^{th} term is 5. The sum of the first 'n' terms of the series (5+5+5+5+…….) can be calculated by simply multiplying n by the constant term in the series.

In the study the same cultural context was used to teach plotting of linear graphs. It was realised that the same context could be used to introduce domains and co-domains in functions. The expression for the n^{th} term of the sequence could also be used to introduce algebra.

It can be observed that the cultural dance context can be used to teach and learn mathematics beyond Grade 9. For instance, by recruiting realistic considerations raised by learners one can start thinking about **bounded sequences**. Although mathematically the produced sequences may be thought of as being infinite, according to the dancers, for the spectators to appreciate the beauty of the dance the number of dancers should be limited. This leads to an upper bound. Such sequences are usually introduced at higher levels, say at University.

Having a possible maximum number of dancers dancing at the same time meant the produced sequence was *bounded above*. Suppose the produced sequence is referred to as $u_n = 5; 10; 15; 20; -; -;$ then u_n is said to be *bounded above* if there is a number M such that $u_n \leq M$ *for all n. M* is therefore representing the upper term (upper bound) in the sequence to be calculated using the maximum expected number of dancers to be in the game. This can easily be understood using the argument that the number of dancers should have a limiting value for the audience to be able to read the dance. The same argument can be presented when introducing the concept of being *bounded below* where this time it's the minimum number of dancers expected in the dance which is used to calculate say m the lowest term (lower bound) of the sequence. We can now say the sequence u_n is *bounded below* if there is a number m such that $m \leq u_n$ for all n. Since there should be a minimum number of dancers for the dance to be performed and a maximum number of dancers to have a sensible dance, the so formed sequence can be said to be both bounded above and bounded below therefore bounded.

The argument presented here is the proposition that by finding school mathematics embedded in non-school activities through mathematisation of activities, the participants in cultural contexts are able to do school mathematics. The logic in this argument is that if learners undertake tasks in their communities that are mathematical then they will be able to do related school mathematics by transferring learning. Learners can acquire learning in response to the constraints and affordances of the learning situation (Gibson, 1997). 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). This is also supported by Thorndike (1901) who in his theory of identical elements argues that successful transfer of knowledge from one task to another is hinged upon the extent of similarity between the tasks. Bransford *et al* (2000) argue that learners transfer knowledge into new learning situations just as they transfer newly formed understandings to other settings.

Teachers should be well versed with the mathematics (through mathematisation of cultural activities) practiced in the local communities in order to provide learners with cues that will allow them to retrieve from memory learnt information that can make current learning easier. Teachers may build on the knowledge learners bring to the classroom by providing opportunities to discuss what they already know about a topic, relating problems to familiar contexts. It is the teacher's duty to build on learners' cultural knowledge. Maier (1991) suggests that individuals fail to utilise school learned procedures because they are not encouraged to relate school experiences to life outside school. D'Ambrosio (1985) has same sentiments. He cites the importance of 'ethnomathematics' within school curriculum, presenting learners with the opportunity to combine and integrate the self-generated methods they use in 'real' situations with school taught algorithms. Clearly these scholars are suggesting that learning can be transferred from one context to another.

Maier suggest that through acknowledgements and discussion of self-generated mathematics outside school, learners will become aware of general mathematical processes and content with which they engage. Maier (ibid) suggests that through acknowledgements and discussions of self-generated mathematics outside school, learners will become aware of general mathematical processes and content with which they engage. It has been argued that transfer of learning is possible and in some cases this transfer is prompted by the teacher. An experienced/expert teacher can facilitate transfer of learning where it appears almost impossible. This is in line with Vygotsky's sociocultural theory principle of scaffolding.

During class discussions, some learners reiterated that they could use their knowledge of number patterns to design different dancing styles. This indicates transferability of knowledge from one context to another. This is supported by Mwamwenda (2010) who posits that what is learnt in educational institutions must not remain there. 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. 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 <u>change the rhythm</u> of the dance. I now understand the Tswana dance better than before.
> J1LD02: <u>I now know how to dance</u> 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 <u>if you don't talk you will find it hard to know mathematics</u>.
> 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 <u>use the activities to understand the mathematics</u> 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 <u>find that mathematics</u>.

The learners' remarks are also support Snowman, et al's (2009) positive transfer of knowledge whereby prior learning facilitates subsequent learning.

To understand the use of school mathematics in cultural dances, the first author interviewed the cultural manager who was also a trainer of cultural dancers. According to the trainer, school mathematics was only useful when training new dancing styles. This is illuminated by the following remarks by the trainer: (M = training manager, R = researcher)

> M: The one who is mathematically literate when it comes to training has an edge over the illiterate one because there is a lot of counting of steps involved. They have to count certain number of steps going forward, backward, and sideways. The mathematically literate one catches faster, whereas the other one might miss out because of the

> mathematical language involved and he/she is sometimes slow, but not impossible as he/she will eventually catch up.
> R: So, the mathematical knowledge is useful when training?
> M: Mathematical knowledge is only useful when training something new. When they all get it chances are, from my experience, the one who was initially slow may even be a better dancer. It comes with passion.

The above remarks trigger the question: can mathematical knowledge be transferred from one context to another? Can we use mathematics to understand cultural activities? It is argued, in literature, that mathematics education for "critical citizenship" needs to emphasise a diversity of situated, social, cultural, and political mathematical practices, giving important attention to the mathematical knowledge that helps to describe and explain those practices – with mathematics as a critical tool to analyse and develop awareness of reality through transfer of knowledge (Agudelo-Valderrama, 2008). The fact that, according to the trainer of cultural dancers, the one with knowledge of mathematics enters quickly into the dance, suggests that "school" mathematics when transferred to cultural contexts may enhance understanding of the cultural dances. This then suggests that mathematics can be used for social empowerment. According to Ernest (2002), social empowerment through mathematics concerns the ability to use mathematics to better one's life chances in study and work and to participate more fully in society. Thus it involves the gaining of power over a broader social domain, including worlds of work, life and social affairs (p.2).

Each culture has got some basic styles which are applied in all dances and mathematical knowledge is basically needed when training these basic styles.

> M: There are some basic styles which are used in each and every dance which can help to move to other complicated styles and as I have mentioned before, every culture has its own such basic movements for all its dances.
>
> R: Ok, suppose we go deeper to complicated styles; does it mean the mathematics being used is also getting deeper?
>
> M: Hmm… (Silence for a while). Maths, like I said before is only needed at basic levels. Like I said before, once the illiterate one catches up at that basic level, even if they get to complicated steps, he can even manage faster than the literate one. In these dancing styles, after catching up with the basic steps it's even simpler to move to complicated styles. Like I said before, it comes with passion.

It seems the manager does not quite answer the question about whether deeper dancing styles also implied deeper mathematics. However, he acknowledges that basic application of academic mathematics is necessary when learning new dancing styles. In fact his argument is in support of the theory of mental discipline, normally referred to as the doctrine of formal discipline. It is believed people who are intellectually endowed pursue difficult subjects because they like them not for the sake of having their minds sharpened – it comes with passion.

As such different number patterns can enhance different dancing styles. Therefore acquisition of mathematical knowledge can assist in the deeper understanding of cultural activities. For example knowledge of bounded sequences can be used to understand the idea of limiting the number of dancers. Since the idea of a limit pervades almost all work in calculus and analysis, the dancing context used in the study can be used in a number of mathematics teaching and learning contexts. It

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can then be argued that knowledge can be transferred from one context to another. Bransford *et al* (2000) argue that learners transfer knowledge into new learning situations just as they transfer newly formed understandings to other settings. However, transferring knowledge raises a number of challenges for bridging contexts. Learners may have knowledge that is relevant to a learning situation that is not activated. By helping activating this knowledge, teachers can build learners' strengths.

Mathematisation of Cultural Artefacts

The first author and the participating teachers mathematised the Ndebele paintings at the cultural village. Different mathematical shapes leading to some mathematical transformations were discovered.

In the first meeting teachers indicated that they were familiar with the activities at the cultural village.

> 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 evident 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? 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. This evidences the possibility of transfer of mathematical knowledge from one context to another. 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

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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. 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 picture below learners can identify shapes which represent different transformations. This may lead to the deeper understanding of the paintings.

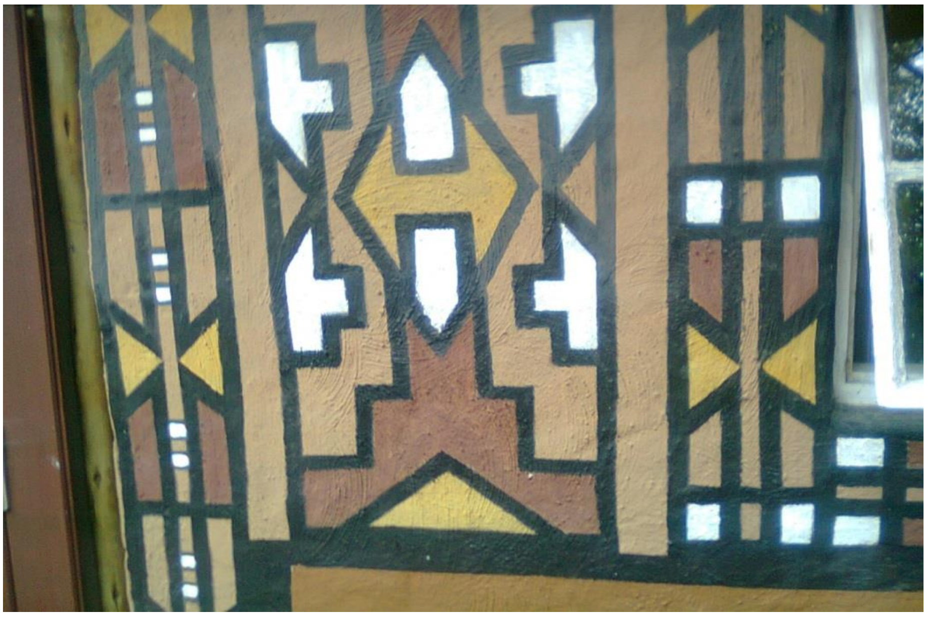

Figure 2: Ndebele paintings

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. This phenomenon brings the issue of transfer of knowledge. Hence mathematical knowledge can be used to boost economic empowerment.

Learners also reiterated that their knowledge of school mathematics may enable them to understand cultural activities better.

> 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. Thus, applying my school mathematical knowledge.

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. 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. This utility use of mathematics is supported by Kufakunesu (2015) who reiterates that mathematics is generally rated as a crucial academic discipline because of its utility in the technological, industrial and economic advancement of any country.

Conclusion

The current study explored the possibility of transferring mathematical knowledge from a cultural context to the school context and vice versa. It is argued that learners transfer knowledge into new learning situations just as they transfer newly formed understandings to other settings (Brandsford et al, 2000). However, learners may have knowledge that is relevant to a learning situation that is not activated. By helping activating this knowledge, teachers can build learners' strengths. According to Snowman, et al's (2009), knowledge can be positively transferred whereby prior learning facilitates subsequent learning. Also, in agreement with Thorndike's (1901) theory of identical elements, knowledge can successfully be transferred if the transformed situation contains similar constraints and affordances to the initial context that are perceived as such by the learner.

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