
Exploring numeracy teaching and learning by using ethnomathematics

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ABSTRACT

The purpose of this study was to explore the impact that the cultural or everyday practices of ethnomathematics of a particular cultural group will have if they are used in teaching and learning of numeracy concepts related to geometrical shapes. It explored cultural practices, artefacts, written, verbal or visual communication messages reflecting mathematics in order to see how they could best eliminate the problems learners encounter in the acquisition of numeracy language. Data was generated using observations, brainstorming and interviews. Based on this research, the impact of using ethnomathematics in numeracy teaching and learning brings in innumerable benefits. These include promoting deep learning and allows teachers to make use of prior knowledge in the classroom. This allows learners to recall and relate to the concepts learnt and employ them in their daily activities so that they do not remain inert. Another impact of interest was the reclaiming of names of geometrical shapes from certain languages which currently teachers are not aware of as they are overlooked. For instance when geometrical shapes were first discussed using local terminology, it made more meaning than when taught using English used as a medium of teaching and learning in the research area.

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1. INTRODUCTION

From the view of D'Ambrosio (1991), ethnomathematics entails the cultural or everyday practices of mathematics of a particular cultural group. Masingila (1993) prefers to refer ethnomathematics as mathematics practice in out-of-school situations. Others might refer ethnomathematics as mathematics embedded in cultural practices of certain indigenous people. In like manner, D'Ambrosio (1991) brings in a theme of culture being involved in ethnomathematics since everyday practices are also a component of culture. The view that ethnomathematics as culture has knowledge can be clear if we understand what culture is.

Spencer-Oatey (2012) argues that the concept of culture is difficult to understand because of the different usages attached to culture. Arnold (1867) considers culture as an intellectual or artistic endeavor in any given society. Tyler (1870) considers culture as a characteristic possessed by all people in all social groups. Finally, Boas (1940) emphasizes on the distinctiveness of the numerous and diverse cultures of unlike peoples or civilizations. On account of this study focusing

on knowledge in ethnomathematics, it will consider the definition of culture from Tyler (1871). Tyler (1871) proposes the view that culture reflects episteme and he defines culture as an intricate whole made up of epistemes, views, craftsmanship, ethics, rules, tradition, and any other competences and practices assimilated by man as an adherent of a society.

How does knowledge in culture come to us? Understanding the socio-epistemic approach can be helpful to answer to this. Muller (2008) who uses the socio-epistemic approach reminds us that the origins and forms of the knowledge in disciplines we have today have their roots in historical struggles and innovations. This informs us that knowledge is intergenerational. This study disagrees with Masingila (1993) and others who opine that there are significant differences between the type of mathematics practices carried out in everyday situations within cultures and the mathematics taught in schools. When communities struggle, the issues they are dealing with are almost the same.

For instance, a single-sited homestead of an old man or woman whom you may assume is innumerate may actually have two sites. One in an area which does not get flooded in summer and another which is prone to floods. In order for him to come out of the situation during floods he uses proportion. He measures how far the flood moves on a daily basis. For him to estimate when the flood will reach his homestead, he engages proportion. The use of proportion allows him to determine when he can move to a homestead which is not flooded, on higher ground. This is a mathematical cultural activity found in some communities. As they encounter problems, there are types of innovative mathematical practices which indigenous communities use to come solve.

It came to the researchers' attention while observing a trainee teacher on school based studies that while she was teaching concepts of spatial relationship, she tasked a learner to use an action to demonstrate his understanding of the word *under*. Words such as *under*, *above*, and *below* are some of the spatial relationship terms teachers in lower primary classes use to develop numeracy literacy. However, as observed in one scenario during this study, a mathematics teacher purposefully placed some blinkers in the learner's cognitive system. She emphasized that the action the learner should take must be one that he has seen taking place in the community as an everyday practice of mathematics.

The learner complied and went under the desk holding an object resembling a hammer. As other learners were fixed on him, the learner, while under the table, started heating under the desk and shouting, "I am a mechanic working under this car. I have failed to remove a bolt under this car using a spanner, now I am hitting under the car where the bolt is so that I deform and force it to come out". Later, the learner moved away from under the table and the class started praising him after the learner asked his classmates whether they now understand the meaning of the spatial term '*under*'. The yes from the other learners reverberated in the classroom.

In contrast, we did not witness a similar presentation in the subsequent scenario when the next trainee teacher was teaching geometrical shapes, a concept in numeracy development. He insisted on the use of terms in English as he was referring to the four geometrical shapes he was teaching namely: *triangle*, *circle*, *square* and *rectangle*. Learners in his class grappled to understand the geometrical shapes' name he had presented. Unlike in the previous lesson, learners responded overwhelmingly when they were asked whether they have understood the meaning of the word '*under*'. However, in this class, learners showed that they were grappling, possibly because they saw the knowledge presented as inert. In such a case there is a need of an epistemic therapy - an idea Beck (1976) perceives as mending cognitive disorders.

So, in such a cases as illustrated , this study delved on finding out how a numeracy lesson in geometrical shapes can be presented using ethnomathematics for epistemic therapy purposes. What impact does the inclusion of ethnomathematics have on the learning of geometry?

Responding to the above research questions requires understanding what ethnomathematics is. Also, there is a need to understand how knowledge in ethnomathematics comes to us. This can be achieved through understanding the socio-epistemic approach about knowledge. Finally, some discussion of epistemic styles which the study used as lenses to view knowledge are presented. These epistemic styles directed the study to develop the ethnomathematics related to geometry which the trainee teacher could have used. Thereafter the study managed to establish the impact ethnomathematics has on the teaching and learning of geometrical shapes such as triangle, circle, square and rectangle.

Theoretical framework and literature

Social constructionism argues that knowledge is socially constructed not created (Andrew, 2012). In social discourse, indigenous communities use observations to precisely reproduce the world. They construct metaphors, analogies and similes using language (Royce, 1973; Aksoy, 2005), and use these to come up with cultural artefacts/explanations, written, verbal or visual communication messages embedded with ethnomathematics that can be used in epistemic therapy in numeracy teaching and learning.

From the view of O'Donoghue (2002) the concept of numeracy may connote a spectrum of things including but not limited to, basic mathematical operations, vital mathematics, social mathematics, mathematics for survival skills in everyday activities, quantitative and qualitative literacy, mathematical literacy and an aspect of mathematical fluency. Such descriptions range from a spectrum of individual abilities from rudimentary skills to high-level mental abilities such as problem solving and communication. These allow one to communicate symbolically, verbally or using written texts. The written texts, verbal or visual communication messages are useful in metaphors or analogies are what the van Hiele (1986) theory of teaching geometry recommends.

Metaphorism epistemic style can embrace written texts, verbal or visual communication messages and can be used in metaphor, an analogy or simile to construct knowledge. However, in this study we took into consideration that a metaphor and a simile are more general and have challenges. Challenges with the interpretation comprise: (i) too numerous conceivable interpretations; (ii) some are too ambiguous and abstract to be interpreted; and (iii) they can be interpreted differently by different researchers (Xu, 2010; Mouraz, Pereiro & Monteiro, 2013). A metaphor reflects beliefs; beliefs focus people's perceptions as they socially and historically construct knowledge (Yero, 2002).

Like an analogy, a metaphor is used to transfer features of knowledge in base domain to features in target domain (Orgil, 2013). Pellegrino and Hilton (2012) refer to this as transferring knowledge from one base domain to the required target domain. The features above allow relating ethnomathematics already known to the intended knowledge. This allows the use of metamorphism epistemic style to recognize that metaphors, analogy and even similes constitute human cognition Snævarr (2010) which have ethnomathematics. The mind finds a match for those features in prior experience with those in the perceived knowledge. The essence of metaphor, according to Xu (2010) is the understanding and experiencing of one kind of thing in terms of another. For a learner in need of an epistemic therapy for him not to grapple in numeracy acquisition, cross-domain mapping in the conceptual system need to be engaged when

ethnomathematics depicting the environment is used. A teacher who believes students learn through active social interaction with ethnomathematics will perceive better levels of classroom talk once the focus is on using metaphors and analogy constructed culturally (Sabatin, 2013; Surovtsev & Syrov, 2015).

The teacher may unconsciously find a match in situations where productive activity is taking place. For instance, use of proportion mentioned before to determine when it is safe to vacate a summer homestead or producing geometrical patterns when weaving cultural artefacts are cases in point (Mukwambo, 2017). The implication is concepts in pattern sniffing of properties of geometrical shapes and proportional reasoning can be taught using ethnomathematics to prevent them from grappling. The choice and use of metaphors is also influenced by the situation in which those metaphors are used; different situations may invite different metaphors in the same teacher and different teachers in the same situation. This is also supported by the idea that metaphorism embraces multiplicity (Benoit, 2012). In the event that the discussed background is considered together with its theoretical underpinnings the following methodology was found to be suitable to come up with the responses to the stated research questions.

Epistemic styles, according to Royce (1973), are constructs which synchronously invoke a valid reality canon. Royce (1973) and Saferstein (2006), identify three epistemic styles which are effective in aiding learners needing epistemic therapy. Epistemic therapy is a necessity since language as a culture might have suffered cultural genocide, which Davidson (2012) considers as a “purposeful destructive targeting of out-group cultures so as to destroy or weaken them in the process of conquest or domination” (p. 1). Language as a component of culture is also destroyed and when it occurs with language, this phenomenon is labelled by Meissner (2018) as linguicide.

Therefore, the three epistemic styles which might help as an epistemological therapy are: rationalism, empiricism, and metaphorism. Dickerson (2010) tags these epistemic styles as: individualizing, systems and poststructural/social constructionist. Earlier, Pepper (1942) suggests four epistemic styles and like others considers them as ways of seeing the world and organizing experiences and classifies them into formism, mechanism, contextualism and organicism.

Rationalism asserts that thought has superiority over the senses with regards to epistemology (Royce, 1973; Saferstein; 2006; Dickerson, 2010). This assertion is shared with individualizing and formism. Empiricism, systems and mechanism maintain that sensory experience is the main way of knowing accurately (Royce, 1973; Saferstein; 2006; Dickerson, 2010). Finally, the metaphorism perspective sees knowledge as flexible, embedded within individuals, socially constructed and symbolical (Royce, 1973; Saferstein; 2006; Dickerson, 2010). This perspective is shared by poststructuralists/social constructionists and contextualists. Organicists value multiplicity and one’s own experience and prior knowledge (Benoit, 2012). Although the study used metaphorism perspective to explore: “*What epistemic therapeutic role ethnomathematics can bring to the teaching and learning of numeracy?*” Other epistemic styles were also valued. The intention was to have the contextual aspects embraced instead of fumigating ethnomathematics reflecting mathematics (Odora-Hoppers, 2001).

To explore this further, ethnomathematics which this study links to epistemic therapy where cultural artefacts or practices, written, verbal or visual communication messages reflecting mathematics play the role of an analogy or models or case study construction Mukwambo (2017) suggests will be analysed and this embraces the idea of content analysis. The aim was to find how ethnomathematics linked to the above epistemic styles can be used as an epistemic therapy in numeracy teaching and learning in classes that are grappling. The belief is that the epistemological

development as a function depends on the three epistemic styles mentioned previously. However, in the case of learners with cultural capital limited to ethnomathematics, the rationalism and empiricism perspective are dormant while the social constructionist perspective is active. This led this study to come up with a methodology where social constructionism was used as a theoretical framework.

2. METHOD

The study used qualitative content analysis method to analyse cultural practices. Cole (1988) and Elo and Kyngäs (2008) argue that content analysis entails analysing written, verbal or visual communication messages and this is the approach this study has. The aim was to find how the ethnomathematics in cultural practices can be used in epistemic therapy to help learners who grapple with understanding of numeracy concepts in geometry. Observation valued in metaphorism was embraced and this allowed the researchers to have a closer look at how indigenous communities from where the learners come from talk about geometrical shapes and how they use them (Saferstein, 2006). Brainstorming was done with the three teachers to hear their views on; *how can a numeracy lesson in geometrical shapes be presented using ethnomathematics for epistemic therapy purposes? What impact does the inclusion of ethnomathematics have on the learning of geometry? How can an ethnomathematics linked epistemic style be used as an epistemic therapy in mathematics teaching practices?* Interviews elucidated the views of three teacher participants and also assisted with data triangulation where one of the participants uses Silozi as mother tongue but the two see it as a lingua franca.

This allowed the evolution of ethnomathematics ideas found during analysis and brainstorming of cultural practices such as written, verbal or visual communication messages. These were used by the three mathematics teachers to come up with case studies, models and patterns related to geometry teaching and learning which they went to use in their practices. While teaching, the researchers observed how the class was conducted to see *how an ethnomathematics linked epistemic style can be used as an epistemic therapy in geometry teaching and learning practices*. To generate authentic data the three teachers were selected on the basis that they are experts in lower primary teaching where numeracy concepts are taught. Themes were constructed from the data generated. These themes were then analysed in order to come up with responses to the three research question which the study aimed to answer. The data generated were presented and discussed.

3. RESULTS AND DISCUSSION

Observations and brainstorming revealed that when lower primary school teachers are teaching numeracy concepts related to geometrical shapes such as a triangle, circle, square and rectangle, they use Silozi language despite the fact that learners in these classes are second language speakers of English as a medium of teaching and learning. Silozi language names these shapes by taking advantage of appearance. For instance, a circle is named as a *sikwenda*. From the view of the three teachers, *sikwenda* means going right round.

In the case of a triangle, in Silozi, it is named as *ñokolwatalu*. Also, the three teachers' view is *ñokolwatalu* means an elbow when bent as it forms three sides. Like in English which names a triangle basing on the fact that it has three angles; Silozi also names a triangle basing on the understanding that it has three sides.

This idea of naming geometrical shapes using sides is also seen when quadrilaterals such as a square and rectangle are named. In light of this, a rectangle, according to these teachers, is called a *simbango* in Silozi, a term which means it has two equal long sides and two other short sides.

Following this idea, another teacher whose mother tongue is Silozi suggested that a *simbango* is an object similar to a house, rectangular in shape. This is where the idea of an analogy, metaphor or simile can fit in very well in the teaching of numeracy involving geometrical shapes (Snævarr, 2010). On the other hand a square is referred to as a *sikweya*, a term which means that all sides are equal. In the case of a square, it does not have a proper Silozi name. This reflects the effect of Silozi as an epistemicide which has helped to bury the local languages in the region, hence an epistemic therapy Royce (1973) and Saferstein (2006) identify as needed to help reemerge languages which have suffered linguicide (Meissner, 2018). Under these circumstances, this is where ethnomathematics as an epistemic therapy is needed to ensure when teaching the naming of shapes (as borrowed from a language which reflects how shapes are named in the community of the learner).

A resistance to Silozi as an epistemicide is seen when the teachers revealed that, the two quadrilaterals, square and rectangle are also named in *Sifwe*, another local language but rarely used in class teaching and learning as *chifokonachifiini* and *chifokonachire* respectively. Both refer to the size of the sides but however, the study noted that the language in *Sifwe* for these two shapes is fast going extinct. This is in contradiction to the theory of van Hiele (1986) which emphasizes that during the teaching of geometrical shapes during the first years of numeracy acquisition, learners should familiarize with names of shapes and the importance of knowing a shape before you are aware of the term involved in naming that particular shape.

In contrast to what was first observed by the researchers when they were on school based studies errands, the first teacher who was observed used metaphorism, a perspective which views knowledge as flexible, embedded within individuals, socially constructed and symbolical (Royce, 1973; Saferstein; 2006; Dickerson, 2010) but the other teacher involved in numeracy development of geometry concepts used a mixture of rationalism and empiricism. The latter had made learners grapple with understanding geometrical numeracy concepts yet he could have looked into the background of the learners to come up with suitable names for these shapes in local languages. Even though Silozi has dominated since it is used as a medium of teaching and learning, this does not mean that there is no other naming of the considered shapes in other languages found in the region.

The most compelling evidence is seen when we consider quadrilaterals, a square and a rectangle. As seen above. Other languages in the region name it as *chifokonachifiini* and *chifokonachire* respectively. *Chifokonachifiini* and *chifokonachire* respectively mean a small shape whereas the latter refers to a shape with four corners which are equal and are big in size. Similarly, a circle has also some other names it comes with from other languages found in the region. It can either be called a *chikwenda* or *cirowindi*. All these text refer to something which is going right round. These are names which embrace metaphorism (Royce, 1973; Saferstein; 2006; Dickerson, 2010). Content analysis, as suggested by Elo and Kyngäs (2008) allows verbal text messages to bring meaning to objects which are being studied such as evidenced from the fact that when learners come across the text which is in their communities they will be in a position to remember the shapes learnt in class. When such shapes are brought into the class the ethnomathematics found in the community is made visible to the learner. The end result is thorough understanding of the geometric numeracy concepts.

In relation to what the teachers said according to the question: *How can a numeracy lesson in geometrical shapes be presented using ethnomathematics for epistemic therapy purposes?*, the response was that this can be achieved through the use of metaphors, similes, analogy and even case studies. This then triggered the researchers to find out; how an ethnomathematics linked

epistemic style could be used as an epistemic therapy in numeracy teaching of geometrical concepts and finally, what impact the inclusion of ethnomathematics could have on the learning of geometry. This is the stage when the participating teachers were tasked to brainstorm on how best they could use the mediating tools mentioned to bring ethnomathematics into teaching numeracy related to geometrical shapes.

Thereafter, the teachers were interviewed in order to solicit their response to the last research question. The second brainstorming led the study to conclude that as a metaphor, the teacher who is teaching the idea of a circle can consider the shape formed when traditional dancers are performing. Then in the case of teaching a circle he can say to the learners that a circle is that shape traditional dancers form when they are performing cultural dances. This can be done with the other shapes as well.

In the case of a simile, the teachers said they would find in the community cultural artefacts which have the same structure as the shapes under consideration and then ask the learners to relate the cultural artefacts to shapes like a triangle, a square or a rectangle. For instance, a rectangle is related to a house floor. This is found in the language used for teaching and learning and is seen as useful in content analysis as Cole (1988) and Elo and Kyngäs (2008) suggest.

In the case of the use of an analogy, the teacher starts from analysing cultural artefacts in the community of a learner by depicting the shape to be taught. This acts as the base domain from which the teacher then launches it to the target domain. This approach is supported by Orgil (2013). With this in mind, one of the teachers suggested that the use of body parts such as folding the arm and showing why a triangle derives its name from such a shape might situate the knowledge and prevent it from being inert as Hale (2013) opines. This removes grappling as observed during school based studies. Understanding the meaning of these names which, according to the socio-epistemic theory, have their roots in historical struggles and innovations of communities, as Muller (2008) suggests, brings a healthy environment for teaching. This implies that one can understand the properties of the shape under consideration as their names are derived from certain actions or cultural artefacts or body parts.

The third stage involved interviewing the three teachers. The focus was to assess the impact of using such an epistemic style which values the metaphorism perspective which sees knowledge as flexible, embedded within individuals, socially constructed and symbolical (Royce, 1973; Saferstein; 2006; Dickerson, 2010). The study established that an ethnomathematics-linked epistemic style that can be used as an epistemic therapy in numeracy teaching of geometrical concepts should involve the use of similes, metaphors and analogies. These mediating tools, however, should be anchored on the metaphorism perspective. It is important to realize that knowledge is socially constructed and symbolical. In the process of coming up with names of the geometrical shapes, teachers could engage with members of the community of practice and thus socially interaction takes place and knowledge is shared as encouraged in constructionism (Andrew, 2012). As a result of this, they come up with names of shapes. The naming of shapes reflects some characteristics which the shape has. When it is in the form of verbal text found in the language of the learner, it becomes easy for the learner to engage in deep learning. Also, the use of symbols, like the folding of the elbow to illustrate how a triangle looks like echoes very well with the metaphorism perspective.

The extent of the impact of the inclusion of ethnomathematics on the learning of geometry was generated from data from interviews. The study revealed that the inclusion allows teachers to take advantage of prior knowledge which they could use in the classroom to foster deep

learning. Deep learning occurs when learners are not memorizing, but the knowledge they gain is put into practical use and can be recalled without any difficulty in future uses.

Biggs (1999) suggests that for deep learning to occur in teaching ethnomathematics related to geometry numeracy concepts, the teacher needs to build on what the learners knows and thereafter, proceed to the unknown. Rejecting this makes learners to grapple. In deep learning, the first thing to remember is that teaching and learning are most effective when new knowledge connects with old knowledge. Teaching should emphasize the interconnectedness of concepts in the official curriculum with those in the informal curriculum - the one used in the home environment and in everyday use to learn about mathematics concepts. In doing so, the connections become explicit and easy to remember.

It emerged from observation and brainstorming that the geometrical shapes under considerations do not have proper names in the other languages used in the region under study. For instance, a square is derived from an English word *sikweya* (from *square*). Also, another anomaly is even the names given to these geometrical shapes using Silozi used as a franca lingua do not appear or are not known in an area where Silozi originated. In another example, the word *simbango*, referring to a rectangle in the study area, has a different meaning in an area where Silozi is used as a mother tongue.

From what the study has observed and stated above, the language related to ethnomathematics has suffered linguicide (Meissner, 2018). So, if the curriculum emphasizes on the use of a term which community members use to name these shapes, then teachers of numeracy concepts related to geometrical shapes will make an effort to go into the community and come up with names of these shapes. In doing so teachers help develop languages which are risk of cultural genocide (Davidson, 2012). The use of ethnomathematics in teaching numeracy concepts related to geometry helps to reclaim some names of geometrical shapes which are just about to go extinct.

Finally, one would see that the epistemic style of metaphorism acts as an epistemic therapy. It effectively assists those learners who are grappling with understanding geometrical concepts to enable them to be literate in numeracy. The impact is deep learning which allows the learners to be in an environment where learning can take place. The perspective of metaphorism helps bring the known knowledge and connect it to the unknown acts as an epistemic therapy. Therefore, it heals the cognitive system of a learner who grapples to understand numeracy concepts.

4. CONCLUSION

As has been noted, the impact of using ethnomathematics in numeracy teaching and learning brings in innumerable benefits. These include promoting deep learning and allows teachers to make use of prior knowledge in the classroom. This allows learners to recall and relate to the concepts learnt and employ them in their daily activities so that they do not remain inert. Another impact of interest was the reclaiming of names of geometrical shapes from certain languages which currently teachers are not aware of as they are overlooked. In the long run, the overall impact of ethnomathematics in numeracy teaching and learning involving geometrical shapes is immense. This often comes with metaphors, similes, analogies and case studies which are within the context of learners. The study had to use some lens to support the ideas which came from the generated tools and these are the socio-epistemic nature of knowledge and the epistemic style of metaphorism. Even though this approach was embraced it still acknowledged the other equally effective approaches. For instance, the empiricism epistemic style was still found to play a vital role since it embraces experiences which are also recognized in metaphorism.

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