Western science knowledge evolve from indigenous knowledge

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Abstract
The incorporation of indigenous knowledge is a contemporary issue in science teaching practices, most useful, in particular in areas where teaching and learning resources are scarce. Indigenous knowledge in this study is proposed as knowledge in the essence of the identities and world views of Indigenous people manifest in their cultural practices. As a contemporary issue, sometimes science practitioners grapple with incorporating science principles in indigenous knowledge as prior knowledge in their practices that might culturally contextualise, authenticate or localise science teaching practices. The need to explore usefulness of prior knowledge found in cultural context paved way for this study in order to answer the research question: What are the enhancers and constraints of using indigenous knowledge to engage situated cognition to ensure that understanding of science concepts is achieved?

To gain insight into the posed research question, this study sought to find out whether the situated cognition approach could be involved through incorporation of indigenous knowledge in under-resourced rural schools in the Zambezi Region, Namibia. Analogies, cultural practices and artefacts in indigenous communities reflecting science were analysed in order to gain insight into how such knowledge can be transformed in order to close the gap encountered when senior secondary science teachers grapple to incorporate the knowledge reflected. Sociocultural theory of learning was used as a theoretical framework and as a lens to look at the data that contextualise science teaching and learning. Additionally, qualitative data indigenous communities have were gathered through observations and brainstorming. Thereafter, analysis of cultural practices in the presence of an indigenous community member was done. Furthermore, four science teachers from the same community in Zambezi Region were interviewed at their schools and their reflections complemented the interview data. Document analysis of Namibian senior secondary science curriculum position on indigenous knowledge and western science knowledge lens were done. Thereafter, such triangulated data were analysed as informed by themes that emerged from common patterns. Some findings from the analysed data were; use of analogies found in indigenous communities can produce a measurable effect in concept learning. The second key finding was that learners' prior knowledge with connotation of indigenous knowledge played a key role in facilitating learning when cultural artefacts and practices were embraced.

Keywords: *contextualised curriculum, analogy, cultural artefacts and practices, indigenous knowledge, western science knowledge*

Background

Some theorists such as Thompson (2013), propose that some approaches such as learner-centred in teaching and learning process is only suitable to the countries from where it originated. This also applies to other approaches and theories of learning. The use of Eurocentric approaches or theories in developing countries such as those in the Southern African Development Community (SADC) has need of a cultural translation (Bhabha, 1994). Bhabha (1994) understands cultural translation as adapting an approach or theory of learning to the cultural context of the area under which it is to be involved. Cultural translation acts as an activity to involve SADC region to adapt curriculum material to suit the Afrocentric view. To Asante (2003), Afrocentrism is premised on perceiving the world through the eyes of an African culture and strives for a more multicultural and balanced approach in order to allow approaches and theories to work in the SADC region.

Schweisfurth (2011) in support reveals in her reports on the success and pitfalls on the implementation of approaches such as learner-centred approach. She points out that learner-centred implementation in SADC region is riddled with constraints. According to her, these range from material constraints, limited resources, poor teacher training programs which do not embrace Afrocentric views of science teaching. Material constraints and limited resources are a result of the curriculum materials anchored on theories of learning which are only suitable to other areas if they are not adapted. Rahmani, Mohajjelaghdam, Fathiazar, and Roshangar's (2008) view is that theories or approaches to learning are desirable and useful in a particular place. The fact that they did not mention the need of theories to be adapted as Bhabha (1994) suggests using the idea of cultural translation allows this study to focus on how indigenous knowledge, a view with cultural connotation can be used to enable theories to be applicable to schools in SADC in order to engage situated cognition.

Such theories may be helpful to a minority group of learners and might hinder learning to the broader group of learners who do not find it easy to adapt in such context. On the other hand equipping trainee teachers with non-aligned Afrocentric programs (Schweisfurth, 2011) benefits non-embracive of Afrocentric views which are not useful for cultural adaptation. There are some worldviews on teachers' disposal that can be used to adapt theories and their approaches to particular areas they are used. If not done, this might cause failure to culturally translate western modern science (WMS) knowledge into useful transformed knowledge for learners whose cultural background is not based on western knowledge systems. As a result, epistemological transfer becomes difficult. Breidlid (2013) sees the absence of materials and improper training given to trainee teachers as privileging western epistemology to flourish whilst that may suppress the individuals' culture of different knowledge view. Breidlid (2013) shares the same opinion with Thompson (2013) as he suggests that western modern science exerts a powerful and controlling effect in such a way that embracing of other views about knowledge construction cannot be entertained in order to culturally translate what needs to be known in WMS. Science teachers' practices adopt a monocultural stance. Mthethwa-Sommers (2014) opposes that notion of viewing science teaching and learning from the WMS perspective as it does not favour a multicultural approach or social justice in facing social realities of SADC region schools.

According to Mthethwa-Sommers (2014) social transmission theories of knowledge are functionalism and structural functionalism. Both DeMarris and LeCompte (1995) and Mthethwa-Sommers (2014) identify functionalism as aligned to the belief that schools should serve to perpetuate the prevailing social and political order. Our view is that without the inclusion of Afrocentric views as Asante (2003) proposes, this might align teaching and learning of science concepts to functionalism. Adherents of social transmission theory, for instance Paz (1987) believes in encouraging assimilation of students/learners into a homogenous culture. Are our cultures in the SADC region homogenous? Considering Mthethwa-Sommers's (2014) opinion that culture is homogenous constrains the use of other knowledge sources to be embraced that can allow the engagement of learner-centred approach and situated cognition approach. This might come with materials, unlimited resources and better teacher training programmes embracing indigenous knowledge worldviews.

On the other hand, (Putnam, 1999; Kaplan, 2004) oppose the existence of a unique perspective in knowledge construction and suggest the idea of non-existence of God's eye view on knowledge to explain phenomena in nature. Activities that indigenous communities engage in reflect empirical knowledge and reality and are revisable at any point, yet science teachers viewed only cultural activities related to WMS as the only ones which reflect reality (Stanley & Brickhouse, 2001). And, in doing so, learner-centred approach and situated cognition cannot be involved in some schools. This is due to materials, limited resources and teacher training programmes non-embracive of other knowledge sources are constraints.

The power and control western science perpetually exerts in SADC education systems makes science teachers mostly embracive of western epistemological worldview and

question the influence that most of teachers' and learners' indigenous knowledge systems bring into education. This favours only those whose cultural background is anchored in that view and makes learner-centred approach acknowledged but highly inapplicable. Situated cognition also, on account of it sharing some similarities with learner-centred approach in that it also supports constructivist theories of learning can also not be involved. Both approaches, support the idea that learners should actively participate in the learning process. But this meets resistance as teachers are challenged by what Schweisfurth (2011) declares as the chief constraint in the implementation of approaches or theories exported to other areas which are not their origin.

In view of these constraints, this study sought to analyse why situated cognition approach can be involved through incorporation of indigenous knowledge in under-resourced rural schools in the Zambezi Region by answering the following research sub-questions:

1. What are the enablers and limitations teachers in the Zambezi Region face when they use indigenous knowledge to engage situated cognition to achieve understanding of science concepts?
2. What role can indigenous knowledge play to act as prior knowledge that teachers can use to incorporate western modern science during situated cognition?

Essentially, this study explored the role indigenous knowledge can play to facilitate engagement of situated cognition in under-resourced rural schools in the Zambezi Region. It aimed to lessen challenges faced in allowing western science knowledge to be successfully constructed through creating conditions for situated cognition approach to be involved successfully in under-resourced schools in the SADC region. Embracing Afrocentric cultural analogies that Gentner (2002) mentions as applied in WMS is acceptable as a science teaching practice since in WMS analogies are used but bear a Eurocentric context.

Theoretical framework

Sociocultural theory was used as a lens to view answers from the research questions of which the main aim was to analyze why situated cognition approach can be involved through incorporation of indigenous knowledge in under-resourced schools. This qualitative study anchored on sociocultural theory used indigenous knowledge (IK) perspectives during intervention to generate science situations of which Aikenhead (2001) suggests can culturally contextualises science teaching practices to emerge pedagogy adaptable to a given cultural context. IK during intervention acted as a medium where WMS evolve from as in Sfard's (1998) opinion.

Sociocultural theory is premised on the understanding that the social and cultural activities which are in each community reflect science concepts. The knowledge can be used as prior knowledge in learning of new knowledge (Vygotsky, 1962). Surprisingly, the individuals' indigenous cultural practices reflecting science are sometimes not infused in science practices in order to ensure that situated cognition is involved in schools which cannot do so. Curriculum materials needed to engage with situated cognition, a theory which according to Brown, Collins and Duguid (1989) proposes that knowledge is rooted in the activity, context, and culture in which it was learned, but those in use in SADC, most are based on WMS only. However, infrastructure reflecting the Eurocentric perspective of viewing scientific phenomenon or concepts is absent in under-resourced schools and hence constraining situated cognition (SC) engagement. Acknowledging how an Afrocentric perspective views science concepts in communities with under-resourced schools sanctions the infusing of IK artefacts and cultural artefacts and cultural analogies. Cultural analogies can be stories with base domain knowledge which can be used to emerge target domain knowledge (Gentner, 2002). Cultural analogies, artefacts and language used to transmit them can be used to facilitate engagement of SC approach. Examples of analogies from the community of a learner can be the cloud, air and ground that can be used to teach the concept of a capacitor in the section on electricity.

Furthermore, sociocultural theory is anchored on the premise that learning is a product of social interaction. Adults who can be teachers and peers play the role of scaffolding novices for them to be in the zone

of proximal development (ZPD) as Vygotsky (1978) suggests. Vygotsky further brings the idea that everything is learned at two levels, namely, interpsychological and intrapsychological (Vygotsky, 1978). The interpsychological also known as the lower mental function is characterized by interacting socially with the knowledgeable individual as Pritchard and Woollard (2010) suggest. Communication is of importance in the interpsychological function where learners as community members serve apprenticeship programs unknowingly in different activities where science concepts are applied as Rogoff (1995) posits.

Learners in their communities assist in cultural activities that employ science knowledge to process food; such as distilling a mixture to make a spirit to be discussed later, fabricating tools for the family or sustaining the environment. In these activities they are unknowingly apprenticed, activities with base knowledge that are analogies reflecting science learnt as WMS are interacted with. Another example is when fermenting milk using indigenous cultural practices for the milk to be preserved longer than any other milk which is processed under normal conditions of not adding additives. Cleaned roots of an *omunkuzi* plant are added. The roots are responsible for increasing the acidity thereby preventing invading bacteria. Lactic acid in milk preserves milk but when roots of the plant are added acidity is increased. This knowledge is transmitted to a novice, the learner by an experienced knowledgeable adult. The knowledgeable adult considers normally fermented milk as the base domain analogy and the milk preserved with roots as the target domain analogy. The fact that the given example contains base domain is an indicator that it is an analogy as Gentner and Jeziorski (1993) and Gentner (2002) suggest that an analogy has base domain which can be mapped into target domain.

In the case of fabrication of materials learners as apprentices witness how a fresh hide is prepared using cultural practices friendly to the environment. Ashes from a *mopane* tree are used to dry the hide and prevent houseflies to spoil it. The dual role this cultural activity plays equips the learner with scientific knowledge involved in a hide processing and how the process is friendly to the environment. The learner sees that chromate compounds used in hide preparation in a Eurocentric institution disturbs the ecosystem in his surroundings if the teacher relates this during a hide tanning lesson.

Relating the science knowledge in the textbook with knowledge gained in cultural practices a learner participates in allows the gained knowledge not to remain inert as Hale (2013) suggests. Such knowledge a learner constructs is analysed in the intrapsychological plain, that is individually and this brings about motivation. This acts as prior knowledge which can be used in science teaching.

At this level a learner uses prior knowledge which Campbell and Campbell (2009) suggest is needed in learning. This is gained in his environment, assimilates or accommodates and he internalises knowledge initially externalised while adding personal value to that knowledge. This forms the basis of knowledge cognition as seen from Piaget (1990). Also, when introduced to WS, IK concepts might play the role of: dominant, equipollent, assimilation, emergence or suppression as suggested in Ogunniyi and Hewson's (2008) five categories in the contiguity argumentation theory. This then might support scientific literacy as science teachers would likely use IK as prior knowledge to scaffold learning in order to acquaint learners with science concepts and constructs.

Importance of prior knowledge

Sfard (1998) proposes that all learning theorists emphasize the need to take into account the prior knowledge as a base of construction of new knowledge. Changes of theories of learning from the behaviourist worldview to the constructivist all emphasize the importance of prior knowledge of learners. Sfard (1998) supports this idea and states that "new knowledge germinates in old knowledge and that has been promoted by all of the theoreticians of intellectual development" (p. 4). Her analysis arrived at encouraging taking cognizant of theories which encourage acquisition of knowledge and those encouraging participation. Situated cognition encourages participation in cultural activities from the learner. Failure to have it involved in under-resourced schools has been attributed to failure to use the right and relevant old

knowledge in learners, for instance, prior knowledge which is indigenous knowledge. This study used indigenous knowledge in learners' environment as an intervention tool to facilitate the engagement of situated cognition (SC) with the aim to answer the research questions stated earlier.

Indigenous knowledge compatible with situated cognition approach

Situated cognition (SC) according to Brown, Collins and Duguid (1989) is premised on the understanding that knowledge is constructed within and linked to doing an activity, context, and culture in which it was learned. In the activity, learners serve apprenticeship programs unknowingly in their communities; context provides the circumstances that make the learner engage in the activities embedded with knowledge. On account of the activities being part of a learner's culture, a learner constructs it to gain social identity (Miike, 2007). A cultural activity or practice teachers adapt during intervention as the premises of SC is explained in the following section.

In the context of this study, is in the four neighbouring schools in the Zambezi Region where the teacher component of the research participants found that there were no fractional distillation apparatus, the factory with fractional distillation infrastructure was far and their learners cannot reach it. Even if an excursion is arranged learners are economically disadvantaged. Instead, the science teachers took the science learners to an indigenous community member (ICM). The ICM uses local cultural artefacts to produce an alcoholic beverage. At the site, the teachers allowed the ICM to give a site talk and learners were allowed to ask questions and even to perform the activities done by the ICM. Thereafter, the science learners pointed out the science phenomenon involved in the whole system they visited.

Back at the individual school, the teachers related the process observed with fractional distillation diagrams in the curriculum material. Learners were tasked to answer some questions related to what they had observed in the curriculum material reflecting WMS and those reflecting IK. The activity done by the teachers during intervention constituted part of what Asante (2013) proposes on how Afrocentric views can be included in science practices. In doing so, this might answer the research question statements seeking to explore: the enablers and limitations of using indigenous knowledge to engage situated cognition to make certain that understanding of science concepts is achieved and also the role that indigenous knowledge plays to act as prior knowledge that teachers can use to incorporate western modern science during situated cognition.

Methodology

This study used analysis of cultural practices reflecting science to intervene and thereafter reveal why situated cognition approach can be involved through incorporation of IK in under-resourced rural schools in the Zambezi Region. Analysis of cultural practices in research involves positioning personal knowledge and understanding into a magnified image of knowledge in a community (Blakey, Milne, & Kilburn, 2012). Analysis of cultural practices was done and was based on observation and brainstorming of practices within a community. To understand the data obtained from brainstorming, cultural practices were analysed, interviews were conducted and reflections obtained from four science teachers teaching senior secondary learners in the Zambezi Region of Namibia.

The use of observation, reflection and activities facilitated triangulation. This also addressed validity. Analysis of emerging data was done by identifying comparable explanations of phenomena which were common in the two knowledge systems, namely, IKS and WMS.

The four participating teachers were tasked to find activities depicting science and their applications. The analysis of cultural practice, its cultural artefacts and jargon in their communities were found and suggestions where they could be used as science-related situations to initiate a science classroom talk (Krajcik & Sutherland, 2010). For the sake of concentrating on one issue and gaining more knowledge on what science knowledge one cultural practice had, the participants after brainstorming selected one cultural practice where a fermented mixture was fractionally distilled to yield a pure alcoholic beverage, by the name *kachipembe*, consumed in the community. The knowledge gained allowed the teachers to take their learners to the site.

Thereafter, the researchers were interested to know how indigenous knowledge could be used to engage situated cognition to ensure that understanding of science concepts was achieved and also might respond to what role indigenous knowledge might play to act as prior knowledge teachers can use to incorporate with WMS. The findings from the data that emerged are presented below.

Findings and discussion

The data generated from observation, brainstorming, document analysis, interviews and reflections are displayed below.

Table 1: Data generated from observation, interviews and brainstorming

Indigenous knowledge concepts / artefacts from which western modern science concepts can germinate in	Relation of concepts / artefacts observed with science concepts in western modern science
Heat supply to an earthenware pot with fermented mixture.	*In a conventional distillation apparatus at school level a flask is in the place of the earthenware pot whereas at an industrial site which learners cannot access large tanks with the mixture are in place.*
Wood or coke supplied as a source of heat in a mapukuta (a device for smelting metals and moulding tools).	*At a site with modern technological infrastructure coke or electricity is used as a source of heat.*
Steam from the earthenware pot is observed escaping as some enters through the delivery tube which is made of a metal connected to a wooden condenser.	*In a school laboratory, the flask is connected to a condenser and all the materials are made from glass but sometimes rubber tubes resistant to heat are used and they are opaque.*
The condenser is made up of wood. Water is poured into it and removed when they feel that it is warm. However, in areas where abundant streams are the wooden condenser is connected to water coming from the stream and is also allowed to flow out.	*The condenser is made of glass and the tubing inside are seen clearly revealing the gas being changed to liquid.*
Distillate is collected in a dish	*Distillate collection at school level is in a beaker.*
Mixture to be distilled comes from many earthenware pots and when the one on the fire has its content used up another is replaced.	*This is also true at school level. When they see that no more steam is coming from the burning contents the one being supplied heat is replaced with a fresh one.*

To gain more insight into how cultural practice can be used as science-related situations to engage SC, audio-visual techniques were embraced. Cultural practices acted as starting points that can be used in science classroom talk which Krajcik and Sutherland (2010) suggest as useful. This allowed gaining more insight into why SC can be embraced as this allowed the participants to analyse the artefact during their own time. Figure 1 below captured some cultural artefacts used for distillation.

Figure 1: Cultural practices involved in spirit production where fractional distillation is used

To understand the views of the four teachers on insight into the enablers and limitations of using IK and WMS to make certain that understanding of science concepts in disadvantaged communities can be achieved, their brainstorming discussions were analysed. The analysis is shown below.

Data from brainstorming

The questions asked in brainstorming were why do you think the practice you selected has science concepts and they are applied by ICM and what can the intervention do for science teachers to incorporate the findings in science teaching? In response they had this to say:

Teacher 1*"Indigenous community members are employing science concepts related to distillation when they process a mixture of fermented fruits into an alcoholic beverage. The indigenous community member representative invited disclosed to us that heating is done to change the liquid to gas. The choice of the pipe they use to connect the earthenware pot being heated to the cooling system takes into account that it need to be a material which does not get burnt as it is near heat. They could have used a straw to pass the gas through the cooling trough; instead, they still opted for a metal pipe. Also, they are selective on the material that the pipe is made of. Copper pipe was used that has good properties to conduct the heat from the gas and in doing so they turn the gas into a liquid".*

Teacher 2 *"Furthermore, the indigenous community member seems to be aware of separating a liquid mixture by taking advantage of the difference in boiling points. Even though they did not employ a fractionating column, they went to replace the collecting container with three other different containers and the contents were never mixed. This might have meant that at different times during the process different substance are produced at different temperatures. The indigenous community member observation as he regularly uses the artefacts, the temperature rises as the system stay longer on the fire".*

Teacher 3 *"Now if we are to intervene, we need to take the learners to the site where this cultural activity is done. The learners must participate and also ask questions on why particular materials are used. In doing so, this might allow learners to familiarise with terms used and when we relate them during science teaching this might bring a change in understanding science concepts related to distillation. Finally, we suggest that since the artefacts are used seasonally, the indigenous community members depend on certain time of the year to have a mixture to distillate. Teachers must have these artefacts in their storerooms. This improves accessibility so that they can refer to them during time they are not being used in the community. This can be done when teaching fractional distillation or distillation as they might allow learners to see how the concepts in fractional distillation are applied in their communities.*

The synthesized teacher 1, 2 and 3 voices reflect the science concepts indigenous communities use, they viewed to be of importance. Also from the excerpts some themes emerged. These themes were WMS is compatible with explaining activities involved, in indigenous communities, engaging SC using activities from IC and social and cultural artefacts are mediating tools. The three teacher's explanation uses WMS to reveal how WMS is used by indigenous communities. Our view is the same explanation is done when a teacher and his learners are at a site with WMS infrastructure that does distillation. The

compatibility which WMS has to explain distillation process at a site with IK infrastructure is an indication that IK enables the teaching of WMS.

Further the analysis of the explanations from the three teachers shows that these teachers went to see that sites where IK practices are performed can be used for SC engagement. They see IK practice sites as grounds where learners can participate in situated cognition while interacting with IC members. Active participation is what Brown, Collins, and Duguid (1989) viewed as constituting SC. Finally, the excerpts from the three teachers revealed that the materials used for distillation in IC were cultural and social that can play the role of mediating artefacts. This is where sociocultural theory used as a lens enables us to see that cultural activities reflect science and this is supported by Brown et al. (1989) who view knowledge as rooted in social and cultural activities.

From our view, teachers' selection of the cultural artefacts did not come with limitations. Instead, this might meet the requirements of engaging a situated cognition approach at a school and enabled to have teaching and learning materials to refer to when teaching science concepts and make them easily accessible to science learners on account of their financial position. In doing so, we view it as preventing transmission of inert knowledge as Hale (2013) suggests.

To validate what was obtained in relation to the research questions the teachers were tasked to do reflections. The excerpts obtained from data generated from these reflections and interviews are displayed in Table 2.

Table 2: Data generated from reflections and interviews

To triangulate data obtained from brainstorming which was presented in the form of excerpts from teacher 1 to 3, we also presented data generated using reflections and interviews. This is presented below. Unlike in excerpts generated from brainstorming, interviews and reflections allowed the four teachers to give their opinion.	Claim supported
Excerpt	
Teacher 1. *Situated cognition engagement in our region is based on taking learners to other regions with western modern science technological infrastructure yet those examples learners view to contextualize are not those learners interact with in their culture. If we then include the cultural practices reflecting science in their communities we might improve engagement of situated cognition*	*Cultural translation*
Teacher 2.*Usefulness of using local indigenous examples reflecting science lies not only in providing some tools to use when conducting situation cognition activities but also comes with the benefit of allowing a learner to interact with what occurs in his social and cultural plane.*	*Sociocultural*
Teacher 3*. Teachers' science language is not blended with* social science jargon *a learner has got already such as situations reflecting science in his community. The terms teachers use improve the way they will explain science concepts.*	*Pedagogical content knowledge*
Teacher 4*. The challenges teachers face when intending to engage situated cognition is lack of materials supporting use of one knowledge source to explain science concepts. Other views of how science knowledge is understood by learners, learners' community or even from the teachers are not used. This perpetuates the sole use of one knowledge source.*	*Social realism*

The data generated and displayed above paved way to come with the findings supporting the discussion. Analysis of data from observation, experiences of teachers and interviews

suggested that the use of cultural artefacts used locally for making an alcoholic beverage and some explanations of how it operates culturally translate science pedagogy Bhabha (1994) proposes. This allows SC to be involved. Learners on account of them knowing what happens in a cultural device such as a *mapukuta*, a traditional furnace using coke to generate heat energy is similar to what is happening in a convectional fractional distillation apparatus or at any industrial site which manufactures alcoholic beverages through use of distillation. Such a scenario is a science-related situation which Aikenhead (2001) suggests is suitable for making learners take a participatory role in science learning since situated cognition will be in place. The relations shown in Table 1 reveal that prior knowledge is necessary in science teaching as earlier proposed by Lakoff (1993), Gentner (1983) and Gentner and Jeziorski (2012). Sfard (1998) understands such type of background knowledge as a medium from which WMS can germinate. Also, this is in support of Rogoff (1995) who reveals that learners already have this knowledge as they are unknowingly apprenticed in such cultural activities that reflect science.

If reference is made that distillation entails separating a mixture through conversion of a liquid into gas and then back into a pure liquid without paying a visit to the site, does not bring aspects of situated cognition to the learning situation. The ideas in WMS to be learnt remain abstract. In most cases, during the teaching and learning process, learners remain with cognitive conflicts as they try to relate concepts the teacher transmits to what they already know. In doing so, time is wasted. Instead of embracing in other concepts the teacher will be still teaching as Piaget (1990) suggests when he explains learning using accommodation and assimilation. This is also supported by Ogunniyi and Hewson (2008) using cognitive and argumentation theory and this case might not be entertained. This loses the focus of teaching and learning using learner centred approach of which learners' context enhances understanding of science concepts built from their culture. The study focused on cultural artefacts observed being used for distillation and suitable to be adapted as an indigenous technological artefact. If embraced, it might address the material shortage under-resourced rural schools in the Zambezi Region. Schweisfurth (2011) suggests that material shortage is the cause of disparities in ways in which approaches and theories imported to SADC region lessen their applicability.

From the interviews teacher 4 said that the learners can even be taken to the site in order to have more understanding of the meaning of change of state. The liquid mixture placed in the earthenware pot changes to gas in view of the observers whereas if taught in abstract the participants would have ended up getting inert knowledge as Hale (2013) suggests. Learning of other concepts through use of cultural artefacts and practices to initiate a science classroom talk (Krajcik & Sutherland, 2010) suggest are necessary and can be made possible as situated cognition is involved in areas where it could not have been involved on account of lack of resources. This is still revealed in Table 1 and Figure 1. Observation revealed that for condensation of the gas to occur, water in the wooden device needed to be maintained cool. Interviews yielded that in cases when a stream is nearby, the cooling system is connected to the stream to ensure that a constant supply of cold water is available. The explained activities which are analogous to what happens in a conventional dry distillation artefact acts as science practices that are science related and Aikenhead (2001) refers to them as important in science development. These are suitable to be labelled as science pedagogies which can elevate levels of engagement of situated cognition in disadvantaged communities. This revelation is also supported from excerpts synthesized from the reflections of teacher 1 to 4 as this can be seen from the excerpt suggesting that science concepts taught do not embrace situations learners are aware of. That might constrain understanding of such science concepts, for instance, the process of fractional distillation and its related concepts together with local and scientific applications.

In Table 2, a suggestion from the teachers in row one was, failure to engage situated cognition was attributed to failure to adapt the curriculum to the context of the learners. Admitting that there is lack of cultural translation (see Bhabha, 1994) conforms to the need to bring some changes in science pedagogies which encourage

engagement of situated cognition for those learners whose cultural, social and historical encounters are not mentioned in the curriculum. The challenge could be as (Kumar, 2010; Lindh & Haider, 2010; Sithole, 2007) suggest that IK is not documented as observed, that data based on it was gathered more through observations, brainstorming and interviews which were the oral and indigenous methods of accessing data in the IK world. That was confirmed by consulting the indigenous community member in this study in order to orally access data which was still in the IK realm of learning. The document analysis, which is a modern method of data gathering technique within science procedures, is widely accepted because knowledge is recorded and it is easy to refer to it. This raised the concern of the teachers since found that their practices were divorced from allowing a learner to interact with what occurs in his/her social and cultural plane (see Vygotsky, 1978).

The knowledge which learners have on cultural practices, artefacts and jargon can be used as pedagogical indigenous content knowledge (PICK). PICK which is a blend of pedagogical content knowledge and indigenous knowledge is vital since it allows learners to actively partake in science classroom talk (Krajcik & Sutherland, 2010) and in doing so they might acquire scientific literacy.

Finally, the teachers went on to suggest that the cultural practices, artefacts and jargon which they had as part of their experiences were also other ways of using science concepts. That is, they saw that science concepts cannot be explained using only one view, but also using other views from other sources as suggested in excerpt 4 in Table 2 and this supports Putnam's (1999) suggestions. The idea of the non-existence of a God's view on knowledge were removed and this suggested some relationship with social realism in which other views to knowledge on certain issues can be accepted in the science community of practice as evidenced from the fact that science explanations in IK are congruent to explanations in WMS.

The concept of fractional distillation is a topic in most science curricula. However, teacher interviews and reflections indicated that teachers did not discuss such experiences. So, the use of IK allows teachers to weave real–world authentic and context based science situations with WS. Intertwining the two knowledge systems possibly leads to learners' understanding of the world and being in a position to solve problems faced by the real world using science procedures to maintain harmony with nature.

The data obtained from the instruments used did not reveal limitations of using indigenous knowledge to engage situated cognition. Brown et al. Duguid (1989) suggest allowing learners to learn by doing in order to make certain that understanding of science concepts is achieved. The data revealed that cultural practices and artefacts found in indigenous communities are suitable for use in under-resourced schools to provide science related situations, Aikenhead (2001) proposes. This is evidenced from the data in Figure 1. Also, in support that IK can be used in situated cognition is the data obtained during brainstorming where teachers went to draw some similarities which are found in the two knowledge systems, namely: WMS and IK.

The role indigenous knowledge plays is also revealed in Figure 1. Besides using IK as prior knowledge (Sfard, 1998; Campbell & Campbell, 2009) teachers can use IK views to incorporate western modern science during situated cognition, IK can also be used in hands-on practical activities and in doing so promotes use of tenets of situated cognition (Brown, Collins, & Duguid, 1989) . The same materials that ICM use as suggested by the teachers can be used in the classroom to relate and conduct hands-on practical activities. The usefulness of IK for incorporation is also evidence from the data from the interviews that teachers revealed in Table 1.

Conclusion

Engaging situated cognition in disadvantaged communities can be achieved through understanding that the curriculum needs to be used as a guideline to come up with a hybrid curriculum. Hybrid curriculum takes cognizance of cultural, social and historical encounters in a community which reflects science in WMS. The cultural, social and historical encounters are part of the knowledge which a learner uses while they engage with any of the five categories in the contiguity argumentation theory. Integrating the observed and discussing activities then allows one to

embrace situated cognition in order for learners to participate fully in a classroom talk. Without taking cognizance of cultural practices, artefacts and jargon, situated cognition might limit SC engagement in schools that are under-resourced. From the instruments used; analysis of cultural practices, observation and reflections reveal that cultural practices, cultural artefacts and language indigenous knowledge employed can play the role of prior knowledge on which WMS is anchored on. Failure to embrace IK as prior knowledge in under-resourced rural schools seems to imply that SC is only suitable for schools with resources.

References

Aikenhead, G. S. (2001). Integrating western and aboriginal sciences: Cross-cultural science teaching. *Research in Science Education*, 31(3), 337-355.

Asante, M. K. (2003). *Afrocentricity: The theory of social change*. Chicago: Library of Congress Cataloguing in Publication Data.

Bhabha, H. K. (1994). *The location of culture*. London: Routledge.

Blakey, H., Milne, E. J., & Kilburn, L. (2012). Data analysis and community research: Comparing reality on housing estates, Bedford. In L. Goodson & J. Phillimore (Eds.), *Community research for participation: From theory to method* (pp. 105-122). Bristol: Policy Press.

Breidlid, A. (2013). *Education, indigenous knowledge and development in the global south: Contesting knowledges for sustainable future*. New York: Routledge.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational researcher*, 18(1), 32-42.

Campbell, L., & Campbell, B. (2009). *Mindful learning: Proven strategies for student and teacher success*. Thousand Oaks: Corwin Press.

DeMarrias, K. B., & LeCompte, M. D. (1995). *The way schools work: A sociological analysis of education* (2nd Ed.). White Plains: Longman.

Gentner, D., & Jeziorski, M. (1993). The shift from metaphor to analogy in western science. In A. Ortony (Ed.), *Metaphor and thought* (2nd Ed.). (Pp. 447-480). Cambridge, England: Cambridge University Press.

Gentner, D. (2002). *Analogical reasoning, psychology of encyclopedia of cognitive science*. London: Nature Publishing Group.

Hale, E. (2013). From inert knowledge to activated knowledge: Practical ideas for improving student learning. *Philosophy Study*, 3(4), 312-323.

Kaplan, D. M. (2004). *Readings in the philosophy of technology*. Toronto: Rowman & Littlefield Publishers.

Krajcik, J. S., & Sutherland, L. M. (2010). Supporting students in developing literacy in science. *Science*, 328(5977), 456-459.

Kumar, K. A. (2010). Local knowledge and agricultural sustainability: A case study of Pradhan Tribe in Adilabad District. *Centre for Economic and Social Studies*, 2, 1-38.

Lakoff, G. (1993). *The contemporary theory of metaphor*. In A. Ortony (Ed.), *Metaphor and thought* (pp. 202-251). *Edition.* New York: Cambridge University Press.

Lindh, K., & Haider, J. (2010). Development and the documentation of indigenous knowledge: Good intentions in bad company? *Libri*, 60(1), 1-14.

Mthethwa-Sommers, S. (2012). Déjà vu: Dynamism of racism in policies and practices aimed at alleviating discrimination. In C. Clark, K. Fasching-Varner, & M. Brimhall-Vargas (Eds.), *Occupying the academy: Just how important is diversity work in higher education.* (Pp. 153-163). New York: Rowman & Littlefield.

Ogunniyi, M. B., & Hewson, M. G. (2008). Effect of an argumentation-based course on teachers' disposition towards a Science-Indigenous Knowledge curriculum. *International Journal of Environmental & Science Education*, 3(4), 159-177.

Piaget, J. (1990). *The child's conception of the world*. New York: Littlefield Adams.

Pritchard, A., & Woollard, J. (2010). *Psychology for the classroom: Constructivist and social learning*. Milton Park: Routledge.

Putnam, H. (1999). *The threefold cord: Mind, body, and world.* New York: Columbia University Press.

Rahmani, A., Mohajjelaghdam, A, Fathiazar, E., & Roshangar, F. (2008). The effect of adapted model of mastery learning on cognitive and practical learning of nursing students. *Iran Journal of Medical Education*, 7(2), 267-276.

Rogoff, B. (1995). Observing socio-cultural activity in three planes: Participatory appropriation, guided participation, and apprenticeship. In J. Wertsch, P. del Iron & A. Alvarez (Eds.), *In socio-cultural studies of the mind* (Pp. 139-163). Cambridge: Cambridge University Press.

Schweisfurth, M. (2011). Learner-centred education in developing country contexts: from solution to problem? *International Journal of Educational Development*, 31(5), 425–432.

Sfard, A. (1998). On two metaphors of learning and the dangers of choosing just one. *Educational Researcher*, 27(2), 4-13.

Sithole, J. (2007). The challenges faced by African libraries and information centres in documenting and preserving indigenous knowledge. *IFLA Journal*, 33(2), 117–123.

Thompson, P. (2013). Learner-centered and cultural translation. *International Journal of Educational Development*, 33(13), 48-58.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard: University Press.