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The Teaching of Scientific Literacy in Disadvantaged Communities

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Abstract

Addressing educational equality is a significant goal in many educational systems across the globe as governments aim to ensure that every citizen is scientifically literate. *Scientific literacy can be understood as every citizen's right to consume ideas from the scientific community. In an effort to achieve scientific literacy, stakeholders in curriculum planning advocate for adaption aimed to contextualize science concepts. A case in point is when a teacher wants to engage situated cognition to teach science concepts. Sometimes this cannot be easily achieved at schools in disadvantaged communities. This is because they lack western modern science facilities that allow learners to interact with members involved in applying science concepts in their everyday cultural practices.* Therefore, in an effort to ensure that learners in disadvantaged communities develop scientific literacy, this qualitative case study explored the teaching of scientific literacy in disadvantaged communities through the use of Indigenous Knowledge (IK) facilities. Data were generated through interviews, observation of community IK practices, brainstorming and teachers' reflections. Four Grade 11 Physical Science teachers sampled purposively participated in the study. Data collected with the use of the above tools provided answers to the research question, '*Which IKS-based science pedagogies can elevate scientific literacy levels in disadvantaged communities?'* Data were thematically analyzed and artefacts such as "*mapukuta*" were examined. The study found that the use of IKS based pedagogies (like mapukuta) can elevate scientific literacy levels in disadvantaged communities. The study recommended that there is a need to introduce science pedagogies which encourage scientific literacy for learners whose cultural, social, and historical encounters are not acknowledged by the curriculum; and *second*, more studies are required to discover how science teachers can be innovative to use out-of-school IK and integrate that with Western Science (WS) situations to address scientific literacy.

Keywords: scientific literacy, contextualize, indigenous knowledge, western knowledge

1. Introduction

Most African countries *subscribe to* and are subjects of constitutional *democracy* (Kpundeh, 1992), which should not only be rhetorical, but should be broadly advocated for and applied. That being the case, it would not be in the interest of the said constitutional democracy if the integration of indigenous knowledge in the school curricula was ignored, or was not considered and applied despite its infusion into the school curriculum. Important to note is that the nucleus of the argument here is that a disregard for IK compromises both *quality of learning* and *equality of the different cultures* represented in the science classroom (Forgeard, 2023). Therefore, to achieve both educational quality and educational equality, countries such as South Africa and Namibia, to mention but a few, shortly after independence overhauled their curricula to integrate IK. In the Namibian curriculum for example, IK manifests in the three Environmental Studies cross curricula themes of the Natural Environment, the Social Environment and Health, Safety and Nutrition (Namibia, Ministry of Education, 2005). Therefore, through these IK laden cross curricula themes, deep learning during science lessons is fostered. Consequently, the aim to integrate IK in Namibia's curriculum was to shift the learning paradigm thus strengthening the basis of learning with local content. In other words, local content becomes the basis for understanding foreign content. This was done not only to preserve this knowledge but to also recognise the multilogicality of knowledge production and its uses in the diverse cultural contexts (Matemba & Lilemba, 2015). For South Africa on the other hand, the aims to infuse IK in the school curricula were threefold, for example:

> *First*, so that South Africans could learn within the context of their cultural knowledge, *second*, to deliver South Africa from a colonial past that subjected the majority of its population to a non-equitable, non-functional place within their own country, and *third*, to address the problems of "redress, equity,

> access and development” by employing a progressive pedagogy that involves “learner-centeredness, teachers serving as facilitators, relevance, contextualized knowledge, and cooperative learning” (Hewson, Javu, & Holtman, 2009, p.1).

Various approaches to teaching and learning, such as learner-centered strategies practiced in Namibia, or an educational theory based on goals such as those of South Africa like *quality* and *equity*, for example, emerged with the hope that scientific literacy for the disadvantaged learners could be improved. Since scientific literacy entails that one is a critical consumer of scientific ideas (Millar, 2006), a critical consumer should thus be in a position to be able to explain a phenomenon in a scientific way, evaluate and plan a scientific investigation, and infer data and evidence scientifically. In this study we see a critical consumer to be one with in depth understanding of a phenomenon, in this case the use of ‘*mapukuta*’ to smelt iron during Physical Science lessons. In order to enhance scientific literacy, IKS were incorporated into science teaching in Southern African countries like Namibia, South Africa, and others, which up to that point, had only used Western Science Knowledge Systems (WSKS). For example, learners on an excursion to a mining town to experience a blast furnace, is a typical example of a WSKS infrastructure, which can, in the case of this study, be replaced by ‘mapukuta’. In this paper, WSKS comprises of the “social norms, ethical values, traditional customs (such as beliefs) and specific artefacts and technologies as shared within the Western sphere of influence” (Le Granje, 2004, p. 84).

Although the learner-centred approach and Outcome-Based Education (OBE) were and are still practised in Namibia and South Africa respectively as Allais (2007) suggests, these were sanctioned to improve scientific literacy. However, some schools are unable to engage in such approaches as they are materially constrained (Thompson, 2013). A lack of technological infrastructure that reflects WSKS in their surroundings prevents learners in such schools from engaging in situated cognition or deep learning and as a result stagnates their mental processes (Wenger, 2010).

On the other hand, schools with the technological infrastructure reflecting WSKS are able to apprentice learners to inbound members in a community of practice (ibid.). Thus, learners in such schools are in a position to develop scientific literacy better than those who are in under-resourced schools. This signals disparities between learners and as a result, equality is not achieved. As Schweisfurth (2011) points out, the implementation of the learner-centred approach is characterized by stories of failure due to a lack of materials. In the hope to address the disparity between under-resourced and well-resourced schools, this study employed the IKS lens to investigate *which IKS-based science pedagogies can elevate scientific literacy levels in disadvantaged communities*.

2. Literature Review

Contextual to this study, ‘scientific literacy’ is a global concept that refers to “what the general public ought to know about science; it commonly implies an appreciation of the nature, aims, and general limitations of science coupled with some understanding of the more important scientific ideas” (Laugksch, 2000, p. 73). The phrase ‘*the more important scientific ideas’* in the above statement is critical to this study as it embraces *‘mapukuta’*, which in the view of this study is a central scientific cultural artefact. In this study, *scientific literacy (IK for example)* does not only speak to or address learners’ understanding of scientific concepts (Laugksh, 2000) but it also facilitates quality teaching and learning as well as promoting equality through the use of local scientific tools like ‘mapukuta’ during science lessons. Deducing from the above, and in all possible understanding, IK is a replica of the wisdom of indigenous people (IP), which as a matter of fact and in all probabilities impact positively on learners’ performance during their engagement with the sciences.

Some literatures on scientific literacy indicate the importance of the use of IK in improving scientific literacy. Using the WSKS lens, Snow and Dibner (2016) identify the significance of scientific literacy as individual, financial, self-governing, and cultural. The Afrocentric perspective on science literacy, the scrutiny of the African genuineness from the viewpoint of the African, one that positions the African practise at the centre (Asante, 1990) is a commodity which is communal not personal (Attuquayefio & Gyampoh, 2010). In sharing IK, viewed in the context of this study as a valuable communal commodity, communities manage to make cultural traditions intergenerational. In so doing, cultural practices are maintained, preserved and protected.

Both views of scientific literacy, personal or communal, value the economic benefits it brings about. Scientific literacy developed using IKS has an economic value and thus a commodity (Newing, 2009). According to Nakata, Byrne, Nakata, and Gardiner (2005), a commodity is a tool that can be used, relocated to other settings, advanced, innovated, unified, mined, and patented. In other contexts, a commodity is what is considered as adapting a science curriculum to suit the needs of those who need scientific literacy. For example, learners in disadvantaged communities are rarely in contact with western modern science facilities. These facilities would allow learners to interact with members of the community of practice (Wenger, 2010). Individuals, who want to chunk a concern or a craving of activities, though scarce, also want to acquire knowledge and implement it successfully (Wenger (2010).

Authors like Mukwambo (2017) suggest that IK as a tool is used in cultural artefacts by teachers during teaching. For example, as models, icons/symbols, vocabulary, patterns, case studies, and practical activities anchored in IK practices to address scientific literacy thus promoting the aspect of democracy in their classrooms.

Self-governing practices in teaching embrace a multicultural view in addressing scientific literacy. Scientific literacy epistemological transfer, according to Breidlid (2013), has observed its advocates applying it as a colonizing tool. This has resulted in those who pretend to be behind its development using derogatory terms related to IK in an effort to exterminate it. As a result, this disconnects indigenous communities from their IK and they become dependent on a WMS worldview.

It is known that IK can be used to address context. Abrahams, Taylor and Guo (2013) acknowledge that learning occurs in communally and ethnically heavily loaded contexts. However, much of the researches that explore the learning on how to be scientifically literate using IK or other knowledge sources are not Afrocentric. An example is Aikenhead (2001) who shows how Aboriginal science can be integrated to improve scientific literacy levels. Not only that, as IK can still do more. For example, in an emerging economy like Namibia, a society hard hit by social ills and pitfalls such as disease, hunger, high levels of illiteracy, and high failure rate, the inclusion of IK in the school curricula is an incentive and alternative to addressing some of these pressing challenges (Van Wyk & De Beer, 2012). Other authors like Asante (1990) might have also revealed how scientific literacy can be improved using IK but have not revealed how the use of a bloomery, *mapukuta* (in Silozi) or *bvuto* (in Shona), an ore and metal smelter device can be incorporated to WSKS to improve scientific literacy when teaching the concepts related to extraction of elements from their ores. It is then the objective of this study to show how some cultural practices such as *mapukuta* can be used to improve scientific literacy in schools in communities lacking western modern technological infrastructure.

Our view is that when IK is used to develop scientific literacy, financial and self-governing factors perpetually act to preserve social and cultural systems. Cultural and social systems interact with each other. This is referred to as a socio-cultural system which this study uses as a theoretical framework.

3. Theoretical Framework

This study, anchored in sociocultural theory, used indigenous knowledge (IK) perspectives to answer the research question and to generate a culturally-contextualized pedagogy (Mhakure & Otulaja, 2017) to improve scientific literacy. Sociocultural theory asserts that the social and cultural activities (the use of *mapukuta*, for example) in each community play a role in scientific literacy (Vygotsky, 2012). In the same vein, Nzwala (2018, p. 38) writes: “a learner brings to class a wealth of societal experiences that form the foundation of his or her classroom learning.” Learners’ societal experiences are socio-cultural, and it is in these sociocultural settings where ‘*mapukuta*’ activities are rife. Nzwala (2018, p. 37) further claims that it is important to understand that prior knowledge or IK is the “raw material that conditions learning, and acts as mental hooks for the lodging of new information which is the basic building block of content and skill knowledge.” Therefore, if IKS are not infused in our lessons as teachers, learner output may not be convincing.

In the communities under focus, the individuals’ cultural practices concerning science are not infused in the science literacy practices at school. Some science teachers believe that science teaching is acultural as viewed by Bang and Medin (2010). That is an alternative way to engage learners. The presence of an Afrocentric perspective of science in under-resourced schools calls for the infusion of cultural artefacts in science lessons to facilitate scientific literacy development. Bhabha (1994) further supported by Maitland (2017) understand this process as cultural translation. This justifies the use of sociocultural theory which has as its bedrock in culture and social interactions.

Sociocultural theory also asserts that learning is a merchandise of social interactions, especially with adults, peers, and teachers (Vygotsky, 2018). Vygotsky (2018) further explains that everything is learned on two planes: the inter-psychological plane and intra-psychological plane. The inter-psychological, also known as the lower mental function, is characterized by interacting socially with the knowledgeable individual (Shabani, 2010). Communication is of importance on the inter-psychological plane where learners as community members are perceived as serving apprenticeship programs in different concepts of science (Rogoff, 1995). The gained knowledge does not remain inert in a learner after acquiring it socially but is analysed in the intra-psychological plane. At this level, a learner assimilates or accommodates and internalizes knowledge initially external while adding personal value to it.

When introduced to western science (WS), IK was used as an analytical framework. Its use is justified since concepts might play the role of dominant, equipollent, assimilation, emergence or suppression. Ogunniyi and Hewson (2008) identify these categories in the contiguity argumentation theory. Also, IK use as an analytical framework has value as it allows patterns in the two knowledge systems to emerge. This then might support scientific literacy as science teachers would likely use IK as prior knowledge. This promotes deep learning as a tool to scaffold learning in order to acquaint learners with science ideas. In other words, IK champions deep learning without which learner understanding of curriculum content may be minimal.

4. Conceptual Framework

Important to understand is that scientific literacy is an acquaintance of various strands related to science such as technology, medicine and environmental issues (Sinatra & Hofer, 2016; Roberts, 2007; Eliot, 2007) and is a process in which individuals are inducted into the community of practice. Roberts (2007) proposes two frameworks to achieve scientific literacy which are Vision I and Vision II. Vision I deals with science merchandises and processes and Vision II covers science-linked circumstances as the initial idea for conversation.

The focus of this study is Vision II which was used to understand which relevant IKS-based science pedagogies can elevate scientific literacy levels in disadvantaged communities. In this study a disadvantaged community is one identified by a lack of technological infrastructure when it comes to WSKS. The study focuses on science-related situations as the starting point for discussions with learners. These situations include the cultural practices, cultural artefacts (like *mapukuta* for example) and the language found in disadvantaged communities.

The negative impact of economic factors on disadvantaged communities means that they do not experience science products and are also not in contact with processes which are labelled as reflecting science using the WS perspective. For example, an ore such as copper mined in an area where a disadvantaged community lives, is unlikely to be processed in that area, but will be sent to a foreign country for processing and sent back as finished product. However, if processing is done locally using a local cultural artefact (*mapukuta* in this case), learners' deep learning is maintained. In other words, the ore is usually transported for processing to a blast furnace far away from the community. Thus, the entire smelting process is purely theoretical or has to be imagined as the learner is unlikely to have the opportunity to witness it. This affects internalization of knowledge, as learners are denied to link up with their prior knowledge, which is their culture, and thus scientifically their mental processes remain low (Nzwala, 2018).

However, at the disposal of these disadvantaged communities, are cultural practices, artefacts, and language that are used in knowledge construction on a daily basis by members of disadvantaged communities. These reflect science concepts taught in schools. The same cultural practice, artefacts, and language are *social*, *cultural*, and *historical* tools used in mediating learning in informal learning. Egodawatte (2012) demonstrates some fundamental features that can be adapted from informal situations and made functional to formal learning situations.

The informal situations Egodawatte (2012) refers to here are what this paper considers as IK encounters which can be used to elevate scientific literacy in disadvantaged communities. In their papers, Egodawatte (2012) and Masingila (1994) point out how ideas in carpet laying can be useful in mathematics teaching and learning. Also, Saxe (1988) studies how informal mathematics in people selling candy can be useful in the formal learning of numeracy skills. All the ideas revealed address the context of this study as focussed on mathematics, an element of science. This justifies this study as no study has yet been conducted in this area.

In this case study, analysis is done to address the scientific literacy of ore mined in an area where a disadvantaged community lives, but is processed elsewhere outside the area despite the existence of similar cultural practices for processing ore in that community. An example of this is a "*mapukuta*". Through the use of *mapukuta*, the ore is reduced to its metal state using heat generated by charcoal. Charcoal which contains carbon plays the role of a reducing agent, as it combines with oxygen in the ore and in the process purifies the ore. Also, a *mapukuta* uses the energy supplied to it to harden metals. The activities in a *mapukuta* are typical manifestations of IK which communities possess and which can be used for initiating relevant science-related classroom talk (Lemke, 1990).

Interestingly, the community members' explanations of how "*mapukuta*" operate are that it softens the metal being heated. This makes it easier when it is hammered; it spreads easily, malleable. The community members' explanation on how it purifies the ore is that the heat generated from burning the ore burns the impurities. That is, the impurities are converted to other substances which will not be able to combine with the metal being extracted.

This type of indigenous knowledge possessed by community members is quite useful in relating science which takes place in a convectional smelter, one which uses a Western modern technological view, and is the one in the learners' curriculum. Adapting of IK allows for its incorporation with WS and, at the same time, addresses scientific literacy.

5. Indigenous Knowledge

Ramnath (2014) identifies indigenous knowledge (IK) as home-grown knowledge, culturally induced, and distinctive to a specified culture or society. It covers a wide spectrum embracing medicine, technology, agriculture, and the environment. It is not static but dynamic and can be common for communities under the same conditions.

For instance, communities along a crocodile-infested Zambezi and Kavango Rivers prefer to swim in the rocky parts of these rivers, with the understanding that rocky parts of rivers are not usually accessed by crocodiles. Crocodiles avoid rocky areas, which could injure their soft bellies. An outsider seeing these locals swimming in these areas of these rivers ends up labelling such locals as people possessing magic, yet they use their home-grown knowledge to avoid dangers in such areas. These experiences are part of their IK embedded in their cultural practices, which can be useful in science-related encounters.

The science related to IK reflected in cultural practices, artefacts, and language can then be harnessed by teachers to improve scientific literacy. It can be used in these pedagogies to elevate scientific literacy levels in disadvantaged communities, which is attainable through cultural translation (Bhabha, 1994)

Bhabha (1994) proposes the need for a hybrid theory when science is imported into an area with obviously existing cultural differences. Teaching using examples from another culture in an area where those examples are irrelevant or alien decontextualizes learning and does not promote the scientific literacy discussed above, and this facilitated the coming up of the methodology discussed below. This has been developed from the ideas of scientific literacy, sociocultural practices, IK, and cultural translation outlined in the above sections.

6. Methodology

This study adopted a qualitative approach and is a case study. Both the approach and design are suitable for this study as they facilitated analysis of data related to '*Which IKS-based science pedagogies can elevate scientific literacy levels in disadvantaged communities*,' the research question of this study. Community analysis in research involves placing individual knowledge and thoughtful judgement into an enlarged representation of information in a community (Blakey, Milne & Kilburn, 2012). The community analysis was based on observation and brainstorming of practice within a community. To understand the data, interviews were conducted, and reflections obtained from four science teachers, sampled purposively, in the Zambezi Region of Namibia.

The use of observation (observing 3 people using 'mapukuta'), reflections, and activities in an expansive learning cycle (ELC) facilitated triangulation and addressed the question of validity and reliability. Data analysis, *thematic in this case*, involved identifying comparable explanations of common phenomena in the two knowledge systems, namely, IKS and WSKS.

The four participating science teachers in the Zambezi Region of Namibia who provided the data were asked to analyze practices, artefacts, and language in their communities, which could be used in science-related situations to initiate science classroom talk. Several practices reflecting science were discussed, and the group eventually selected a practice involving the smelting and casting of ore.

After the selection of the practice and brainstorming, the following activities formed the expansive learning cycle (ELC): questioning, analysis, modelling, examining, implementing, reflection, and consolidation (Engeström & Rantavuori, 2013). The major questions raised were about the science activities reflected in the practice. Analysis entailed observing the activities which the community members were doing when the participants visited the site. The knowledge gained enabled the four science teachers to model the relevant activities to carry out with learners in the science classroom. After that, as part of honing scientific literacy, the activities were re-examined to detect flaws in the use of the "*mapukuta*".

7. Findings and Discussions

When everything was found to be possible, the four teachers went to implement the ideas in their classrooms. Finally, reflections from teachers were obtained when they did the consolidation of their practices. The data generated from observation, brainstorming, document analysis, and interviews are below.

Table 1. Data generated from observations, interviews, and brainstorming

Tools for mediating learning which were observed.	Relation of tools observed with science concepts in recommended textbook.
1. Fresh air supply to the burning point.	In a blast furnace fresh air is also supplied but it is hot.
2. Coke supplied as a source of heat.	In a blast furnace coke is also supplied but at a certain stage it is turned into powder for the purpose of increasing the rate of burning.
3. Flame changes colour.	A hazy red, growing to brighter yellow flame as the temperature went up, and ultimately produced a bright white glow, and this can be used to determine the temperature at which the *mapukuta* are burning using a colour temperature scale.
4. Metal poked into the fire becomes incandescent, producing different colours as time increases.	Also a range of different colours produced at different temperatures.
5. Hammering the metal object without breaking.	Heating in the *mapukutu* prevents the metal from being brittle.
6. Use of tree bark to handle the hot metal when removing from the fire and hammering.	Insulating concept when a hot body is handled.

To gain more insight into how cultural practices can be used to *elevate scientific literacy levels in disadvantaged communities*, the procedure of using the *mapukuta* was filmed for later discussion and analysis. Figure 1 shows a metal-worker with an assistant at a site where a “*mapukuta*” is used.

Figure 1. Data generated from observation

The four participating Grade 11 teachers were asked to reflect on whether science pedagogies to facilitate scientific literacy in disadvantaged communities can be achieved through infusing IK and WS. Data generated from these reflections are displayed in Table 2 below.

Table 2. Data generated from reflections and interviews

Excerpt	Claim supported
1. Scientific literacy in our region is low because the examples we use to contextualize are not the ones those learners interact with in their culture. If we then include the cultural practices reflecting science we might improve scientific literacy.	Cultural translation
2.Usefulness of using local indigenous examples that reflect science lies not only in providing some tools to use when conducting practical activities but also comes with the benefit of allowing a learner to interact with what occurs in his social and cultural plane.	Sociocultural
3. One of the challenges learners encounter is to relate what the teachers are saying with what they already know. This challenge can be eliminated when teachers' science language is blended with social science a learner has got already such as situations reflecting science in his community. The terms teachers will use improves the way they will explain science concepts.	Pedagogical content knowledge
4.The challenges faced by the learners when the teachers explain science concepts is teachers only consider those examples mentioned in the curriculum material which uses one knowledge source to explain science concepts. Other views of how science knowledge is understood by learners, learners' communities 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 the way for the findings and discussion below. Analysis of data from observation, experiences of teachers, and learners' science situations, as well as interviews suggest that the use of cultural artefacts such as *mapukuta* together with explanations of how it operates may be used to translate science pedagogy, thus elevating *scientific literacy levels in disadvantaged communities,* which supports the *theme* of pedagogical indigenous content knowledge.

Since learners are familiar with the use of "*mapukuta*" for example, they can apply this to operations in a similar, but unfamiliar blast furnace scenario. This would then address Vision II of scientific literacy discussed in the section on the conceptual framework. The activities seen done in a "*mapukuta*" are also done in a blast furnace, but it is only in a "*mapukuta*" where learners are apprenticed (see Rogoff, 1995) and can see what would happen in a blast furnace.

If the learners are merely told that in a blast furnace a blue flame is used for burning the ore, the information would remain abstract since they have never seen a blast furnace. However, since the learners know about and have seen the "*mapukuta*", and are aware that the more air pumped into it results in a blue flame, they then relate and understand that it needs a constant supply of air to function efficiently. They also know that the air is constantly supplied using pumping activities. The "*mapukuta*" is, therefore, a valuable indigenous technological artefact that can be used to address the material shortage (Schweisfurth, 2011) in under-resourced schools, and as a consequence elevate *scientific literacy levels in those communities*.

The teachers interviewed also realized that the learners could be taken to a local site in order to understand the meaning of "incandescent" because the ore placed in the "*mapukuta*" becomes incandescent after heating. They could then apply this understanding to what happens in a blast furnace. Observing relevant science examples locally addresses situated cognition and fosters scientific literacy without incurring unnecessary expenses in terms of transport costs.

Other concepts can also be learnt through the use of a "*mapukuta*" to initiate science classroom talk. For example, the *mapukuta* operator uses a tree bark to insulate himself from heat. 'Insulating' is a science language term which learners might not know unless they can relate it to the metal smith protecting himself from heat. In addition, it was noticed that the heated metal is not brittle, nor does it break without significant plastic deformation.

The activities in a "*mapukuta*" which are similar to what happens in a blast furnace, are relevant science practices that can be labelled as science pedagogies which can elevate scientific literacy levels in disadvantaged communities. This is also supported in the teachers' reflections which indicate that currently, science concepts do not embrace situations learners are aware of.

In Table 2, a suggestion from the teachers in row one attributed learners' lower scientific literacy level to the failure to adapt the curriculum to the context of the learners. In admitting that there is a lack of cultural translation (see Bhabha, 1994), we feel there is a need to introduce science pedagogies which encourage scientific literacy for learners whose cultural, social, and historical encounters are not acknowledged by the curriculum. The cultural practices were cited as tools to mediate the teaching of science concepts related to blast furnace activities (Table 2, excerpt 2). Teachers noticed that their practices up to that point did not encourage learners to interact with material and experiences from their own social and cultural planes (see Vygotsky, 2018).

To blend science language with the language found in Vision II, Roberts (2007) proposes a practical, civic, and cultural approach to introduce pedagogies to foster scientific literacy. This manifests the *theme of social realism* where the other constructs like cultural translation and sociocultural views are embedded. The knowledge about cultural practices, artefacts, and language which learners have can be used as pedagogical indigenous content knowledge (PICK), which is the theme. PICK, which is a blend of pedagogical content knowledge and indigenous knowledge, is vital since it allows learners to participate in science classroom talk, thus helping to elevate learners' scientific literacy in disadvantaged communities (Shulman, 1987).

Finally, the teachers suggested that the cultural practices, artefacts, and language which they had as part of their experiences constitute other ways of using science concepts. This is multifaceted, as according to them, science concepts should not be explained from only one cultural perspective (Table 2, excerpt 4). The idea of the non-existence of a God's view on knowledge was removed, and this suggested a relationship with social realism which accommodates other knowledge views in the science community of practice as evidenced by what happens in a blast furnace and in the "*mapukuta*."

The concept of the blast furnace is a compulsory topic in most science curricula. However, teacher interviews and reflections indicated that teachers did not draw relevant local parallels with the workings of a blast furnace. Drawing parallels and adducing culturally familiar examples is critical as this can elevate scientific literacy levels in disadvantaged communities. The use of Vision II framework as what is understood as scientific literacy meets with what Millar (2006) sees as making one become a critical consumer of science-related encounters. So, the use of IK, also referred to as informal situations, allows teachers to weave in real-world, authentic science situations with WS.

8. Recommendation

Sometimes it is unachievable to incorporate wholly IK scientific ideas that are used in IK situations to prescribed contexts in order to address scientific literacy. Therefore, more studies are required to discover how science teachers can be innovative to use out-of-school IK and integrate it with WS situations to address scientific literacy. The studies of Egodawatte (2012), Masingila (1994), and Saxe (1988) reveal that many concepts in current science curricula take advantage of contextual, non-formal learning to bring more meaningful and learner-friendly materials, thereby addressing science literacy. The concepts the authors discussed emphasize science-linked circumstances as the initial idea for conversation to address contextual problems learners might face. The analysed concepts in IK are that cultural practices are useful to address science literacy. On the same note, the *mapukuta* artefact has some cultural practices which can similarly be used to address scientific literacy in learners in schools that are in disadvantaged communities.

Each of the discussed cultural practices comprises a collection of ethnic customs, practices, and belief systems that reveal thinking patterns. Changing the focus may bring socialization patterns. These bring the knowledge in the cultural practices that members of the community use thus bringing such knowledge closer to the learners. As a result, learners value what they see in the community. It is the constructed knowledge involved that can be used to answer the research question.

Knowledge construction observed in IK practice sceneries is disseminated amid cognitive system, body and action, or conduct. Examining scientific literacy cognition in use within a particular setting, and viewing the cut-off between situations, will deliver a foundation for trailing thought. This foundation serves as a link of associations amid the cognitive system at work and the environment where the concept is applied. Also, both official and non-formal learning are home-grown, and members of the community of practice are the teachers in this undertaking.

Segregated strategies and culturally inspiring resources, for instance, the use of *mapukuta* as a model to address scientific literacy, requires embracement in conceptual development. Extra potential innovative pedagogical strategies used today use cultural practices as case studies where science patterns in IK are sniffed and matched with those in WS. This prevents the manipulation of science concepts which are not contextualized and used to raise scientific literacy in vain.

To mitigate the manipulation of these science concepts, cultural context needs to be given high precedence in official school curricula to achieve scientific literacy. The socio-cultural approach Vygotsky (2018) proposes, and the cultural translation Bhabha (1994) brings are standard and fitting endeavours regarding the importance of IK during science lessons. They necessarily involve enabling or limiting admission to worth-laden resources.

We additionally accentuate learning as partisan in the sense that it is facilitated by cultural, historical mediators and social practices that may limit admission to scientific literacy chances for some persons or collections of people while at the same time enabling access to other groups of persons.

Occasionally, the constituents of the curriculum, prescribed textbooks, syllabus, and other teaching support materials are half-baked and favour definite clusters in society. Isolating a curriculum into ranks, such as practical, academic, or vital, might deny some individuals access and this may interfere with principals' fairness as diverse views are compromised

To make them assured in the scientific literacy development process, it is vital to stress the need for alertness of social worlds where individuals construct their own knowledge. The central question for teachers who facilitate this process is, *"Which IKS-based science pedagogies can elevate scientific literacy levels in disadvantaged communities?"* It is not difficult to find patterns in cultural artefacts or practices since there exists numerous interconnected cases. Still, scientific literacy tools, for instance, language, cultural practice, and cultural artefacts play a vital role in this process. For instance, teaching using models and languages of the learner might allow students to be more contented and be greatly helpful to them.

9. Conclusion

Scientific literacy for disadvantaged communities can be achieved through understanding that the prescribed curriculum is simply a guideline that can be adapted to hybridize it. This implies that teachers as curriculum implementers are charged with the task to take cognizance of cultural, social, and historical factors in the communities they serve. This should be done to strengthen the learning and comprehension base of learners. The cultural, social and historical encounters are a part of the knowledge learners are destined to use when they engage with any of the five categories in the contiguity argumentation theory (Ogunniyi & Hewson 2008). Integrating the discussed activities allows one to be scientifically literate in order to participate fully in their communities. Without taking cognizance of cultural practices, artefacts, and language, educational equality is compromised and results in short-changing learners. Vision I framework, which covers science products and processes, lacks in disadvantaged communities but the use of science-related situations proposed in Vision II might foster scientific literacy development in those communities.

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