Opportunities of Incorporating African Indigenous Knowledge Systems (AIKS) in the Physics Curriculum

Mathias Sithole

Abstract
The need for economic and physical survival has been identified as a primary motivating force for technological advancement (Clark 1997). This study explores what can be learnt and gleaned from indigenous technologies that add to the theoretical conception of African Indigenous Knowledge in general and indigenous Physics in particular. The descriptive research design was used to illustrate how this can be done. Documentary, experiential and observation methods were used to gather data. The study reveals that African Physics based knowledge can be incorporated into conventional physics in order to enhance African students' appreciation of physics. Physics has always been generated in order to solve societal and natural challenges like weather changes, shelter, communication, food and diseases. The study also argues that African societies had and still have Physics concepts which resemble formal school Physics. Therefore, it makes sense to use the existing African physics to develop the conventional concepts. The study suggests that Physics learners can apply their prior African related physics knowledge in order to k reduce the seemingly mystifying nature of conceptualisation of physics concepts as experienced by some learners. The study encourages curriculum developers to incorporate African Physics knowledge into the Physics curriculum. The study concludes that if African physics is taken seriously, it can help in the regeneration and enhancement of knowledge.

Keywords: Indigenous Physics Education, African Indigenous Knowledge Systems

Introduction

Contributions made by Africa and her people to history and civilisation are conspicuously missing from text books for formal education and remain unknown to many (Abiodun 1998; Ngara 2007; Keane 2013). Research has shown that it is against this background that the various aspects of indigenous physics knowledge systems (IPKS) should be resuscitated. Therefore, the paper analyses some aspects of IPKS in a Zimbabwean context. The study intends to focus attention on the existence of physics aspects in Zimbabwean culture, with specific reference to southern Manicaland Province. . The study also argues that IPKS, as defined by Mapara (2009), are still in existence. When learners acquire new knowledge at school, they already have pre-conceptions based on their daily experiences and what they learn from those around them (Gwekwerere in Shizha & Emeagwali 2016). Such experiences represent learner prior knowledge. Within a constructivist approach to learning physics, prior knowledge had been found to underpin learning in a significant way – either as a hindering or helping factor. The major concern is to identify the reason why learners fail to see the connection between school physics and their real life experiences.

One key issue that impacts on effective learning of science in Africa has been the controversial status of prior knowledge that learners bring into the classroom. Further, this study's thrust is to heighten awareness, stimulate new thoughts and generate discussion on the wealth of IPKS. According to Mapara (in Sithole2016), there have been many ongoing discussions on IKS. It is the intention of this paper to contribute to critical discourse about identifying IPKS and incorporating it in the physics curriculum.

Knowledge of 'Physics' and its methods of investigation cannot be divorced from a people's history, cultural context and worldview (Gwekwerere in Shizha & Emeagwali 2016). Society acquired physics concepts through its cultural values and norms. As Mapara (2009) notes, worldviews shape consciousness and form the theoretical framework within which knowledge is sought, critiqued and understood. . It is indeed most gratifying to see that some African scholars believe that African indigenous knowledge systems have much to contribute to existing Western knowledge and methodologies, and therefore have taken on the important yet daunting task of making knowledge relevant to African realities. . The theories include those related to knowledge acquisition, readiness of the mind to assimilate the information as well as the methodologies used to transfer information from generation to generation.

The Contextual Meaning of Terms

Physics and Physics education do not mean exactly the same thing. . Physics involves the study of matter and energy in its different forms, and the transformation of matter and energy (WordPress 2011; Wikipedia Feb. 2016). Some examples of physics concepts include heat, electricity, flotation, gravity, magnetism, kinetic theory, robotics and elasticity. Such examples indicate natural dimension of nature in which human beings exist as well as co-exist. Physics constitutes a curriculum given that 'curriculum' is a concept that includes knowledge and content (Gumbo 2016).

Unlike Physics, Physics education refers both to the methods currently used to teach physics and to an area of pedagogical research that seeks to improve the methods (Wikipedia Feb. 2016;). For instance, Wikipedia indicates that when physics is initially taught primarily by the lecture method to confirm concepts, the lectures should be accompanied with demonstration, hand-on experiments, and questions for students to ponder what will happen in an experiment and why. This helps students to learn by trial and error they learn to change their preconceptions about phenomena in physics and discover the underlying concepts. Furthermore Wikipedia indicates recitation and lecture-cum-demonstration, as other methods **of** teaching physics. The second term, 'indigenous', refers to any knowledge naturally existing in a place. For this discourse indigenous is a large body of knowledge and skills developed outside the formal education system in pre-colonial societies.

IKS are located within a certain cultural context (Muchenje, Gora & Makuvaza 2016). Warren (1991) and Flavier (1995) define Indigenous Knowledge (IK) as the local knowledge – knowledge that is unique to a given culture or society. IK empowers members of society with abilities and capabilities to deploy and employ practical techniques and skills to manage their natural environment and to find ways to solve human problems (Emeagwali & Shizha 2016). For that reason IK is mostly concerned with the utility, accessibility and practicability of knowledge. IK contrasts with the international knowledge system generated by universities, research institutions and private firms. Warren (1991) adds that IK is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities.

The term ‘Indigenous Physics’ denotes the study of knowledge of matter, energy, forces, skills and philosophies developed by societies during interaction with their natural surroundings (Sithole 2016). Indigenous Physics constituted the local knowledge which was critical in decision-making and fundamental aspects of day-to-day life. The community needed Indigenous Physics so as to develop technology viewed as a communal necessity and enterprise (Shizha in Shizha & Emeagwali 2016).

Indigenous Physics Knowledge as a Tool for Societal Survival

Research has shown that African indigenous knowledge systems are based on the natural environment and human sustainable development (Emeagwali & Shizha 2016). In other words, the society had to succumb to the dictates of the environment in order to survive. Horsthemke (2008) argues that indigenous science is holistic as it draws on all the senses, including the spiritual and psychic. Therefore a holistic understanding of indigenous knowledge systems should uphold an integrated perspective that includes both the spiritual and material aspect of a society as well as the complex relationship between them (Hewson and Ogunniyi 2011). Consequently, people remain embedded in the natural world. In addition, Hewson and Ogunniyi indicate that indigenous knowledge is the local knowledge (knowledge is unique to a given culture or society). From this analysis, indigenous knowledge is the information foundation for the public which enables easy exchange of ideas and choice making. Indigenous knowledge systems are dynamic and are continually influenced by internal creativity and experimentation as well as by contact with external systems. There has been improvement in the various forms of technology because people have the inherent behaviour of making comparisons when they interact with others.

Ellen and Harris (1996) argue that indigenous knowledge is also the social ‘capital’ of the poor, their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own life. Furthermore, Ellen and Harris indicate that indigenous knowledge is part of the lives of the rural poor; their livelihood depends almost entirely on specific skills and knowledge essential for their survival. Indigenous knowledge is relevant to a particular society; it forms part of global knowledge, and should be recognized, valued and appreciated.

African Indigenous knowledge Systems (AIKS), are critical components in the quest for the provision of quality education for all. AIKS are rooted in traditional systems of beliefs, which indigenous people use to understand and interpret their biophysical environment (Abiodun 1998). Abiodun further observes that AIKS embodies a wealth of wisdom and experience of nature gained over millennia from direct observations, and transmitted (most often orally) over generations.

Economic and physical survival have been identified as significant motivations for technological advancement (Clark 1997). Indigenous Physics knowledge was generated in order to solve societal and natural challenges. Therefore, indigenous or conventional physics is meaningless unless it solves societal problems. Physics notions have been there from ***time immemorial because they were solutions to societal challenges.*** For that reason, no one can claim to have generated physics knowledge and passed it on to other societies (Mapara 2009). It was naturally available to all societies in different forms and stages of advancement because every society faced life challenges like weather changes, shelter, communication, food, diseases and war, among many.

Citing several examples and scenarios, this article argues that the notion of present-day Physics taught in educational institutions existed in African society and many other societies prior to its introduction by imperialist powers. However, when it appeared in text books for African learners, it was not entirely new to them. It makes great sense to use the locally understood physics concepts (or 'native physics') to develop the conventional laboratory based physics concepts. This article aims to continue the discussion along the above lines but with the express objective illustrating how Physics teachers/lectures can draw on indigenous (African) knowledge as they teach concepts and introduce terminologies in the physics curriculum.

How Indigenous Physics Technologies can be Incoporated into The Physics Curriculum

According to Sithole (in Shizha & Emeagwali 2016), IPKS are observable in innumerable ways. It is crucial to navigate in which ways IPKS are available in society. First, the practice of archery is shown by figure 1.

The Bow and Arrow (Archery)
Figure 1: Bow and arrow

Source: Photographed by the author (2015)

Sithole (in Shizha & Emeagwali 2016), explains that during pre- historical times, indigenous people used bows and arrows to hunt for wild game and defend themselves in times of war. The choice of a particular wood type involved critical craftsmanship as well as problem solving skills. The shape of the arrow shows high level of physics. The feather attached gave direction to the arrow. The curved shape of the bow was able to withstand compression forces, thus demonstrating its strength and speed. Strong fibre or animal hide material was chosen to make a string of the bow which had to resist tension forces. Sithole (2016) points out that the string had a high elasticity, making it not stretch easily. This allowed the bow to bend. Thus the potential energy in the bow-string system increased. As a result there was energy conversion. The potential energy turns into kinetic energy in the fast moving string. There is a very interesting physical phenomenon in the physics behind archery, known as Archer's paradox. When an arrow is released to the left (or right) of a bow and is deliberately aimed off target, it will straighten out during release and hit the target. Hence in order to hit the intended target, hunters would deliberately aim away knowing that the arrow would straighten out. Though they learnt this from experience, they still managed to display profound knowledge of

Archer's paradox. Sithole (2016) further argues that the bow and arrow as well as the archer can be used to teach physics concepts and well understood by many learners. Physics concepts like acceleration, force and gravity, among other related concepts can be best understood through use of the bow and arrow. A teacher can discuss such concepts prior to conducting the following experiments:

- Conducting a centre of gravity experiment
- An object falling through water reaches a constant terminal velocity after falling relatively small distances. This terminal velocity can be seen and measured.

The concept of bow and arrow was deliberately and orally passed from generation to generation for certain reasons (Sabinet 2015). Equally important to note is that great research occurred towards improvement of the bow and arrow. Users of such technology kept on sharpening their skills to make the bow and arrow better in both performance and durability. The practical design skills developed here can be incorporated in the physics curriculum.

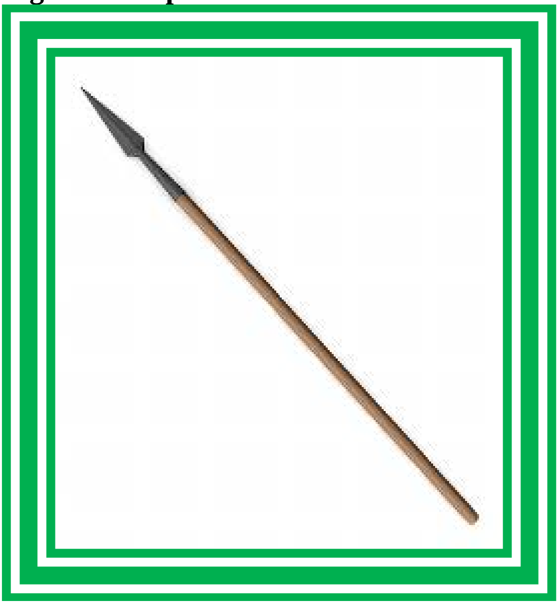
Spears

The spears were normally used in tandem with bows and arrows to aid in both hunting and war (Sithole in Shizha & Emeagwali 2016). The spear had to be light and strong. The choice of the appropriate material was a result of critical thinking. The two most important factors involving the physics of throwing a spear are the centre of gravity and centre of pressure. The centre of gravity is near the grip and does not change during throw. Master hunters learnt to utilize these concepts and attack angles to produce the maximum spear distance with greatest impact. Throwing at the optimal attack angle is throwing the spear at the angle at which the air flows most efficiently around the spear. To produce maximum distance, the spear must be thrown at the attack angle to minimize drag and maximize lift and speed. The attack angle for throwing in a head wind is slightly more down causing less lift than when a spear is thrown into a tail wind. According to McGrath (2010), children acquire science concepts through enquiry about the proper usage the spear. This is a demonstration of critical and problem skills. Sithole sees science as a process of identifying properties, discovering relationships and searching for answers. Examples of such objects can be incorporated in the physics curriculum (Sithole in Shizha

& Emeagwali 2016). Some of the experiments that link with these ideas are as follows:

- Defying gravity experiment; and
- Verifying the principle of moments.

Figure 2: A spear



Source: Photographed by the author (2015)

The Catapult

Sithole (in Shizha & Emeagwali 2016) argues that the catapult was made up of a piece of a hide attached to string of fibre string. It was used to throw stones as illustrated in Figure 3 above or at a tangent after a circular motion. Today circular motion appears as a physics concept (for instance $F = mv/r^2$). The concept of catapult design and use was again passed on from one generation to the next. For that reason, catapult physics concept became a life science. The catapult concept can be linked to elasticity notion. A teacher can mention it before learners do elasticity experiments such as:

- Conducting a bouncing experiment to determine elasticity of materials such as rubber, ping pong, and marble;
- Conservation of momentum; and
- Investigation momentum during collision.

Figure 3: The catapult

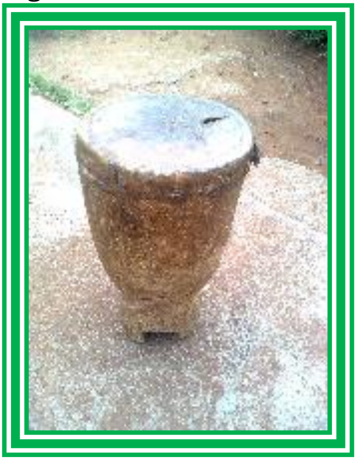
Source: Photographed by the author (2015)

Sithole also indicates that the concepts of elasticity, linear and parabolic motion constitute indigenous African Physics knowledge. Such theoretical and practical skills acquired in the use of the catapult could be incorporated in the Physics curriculum.

Sound Communication

According to Sithole (in Shizha & Emeagwali 2016) communication challenges caused some local people to practise mouth whistling. The mouth was slightly closed to produce sound. Whistles were used as call signals as well as alert signals to each other. Dogs made howling sounds if lost. The shepherd gave direction to animals through a whistle. The drum made of animal hide was used to give signals of impending events such as war and important meetings. People knew how to give variance to drum volume. In African culture, the drum is a means of communication and self expression. Its broad variety of users includes early African tribes and Native Alaskan tribes: both tribes used drums Africans brought drums with them to the Americas and helped to develop their popularity among American musicians.

Figure 4: The drum



Source: Photographed by the author (2015)

Drums use physics concepts to do with waves and resonance. The sound waves for an open ended and stringed instrument is fairly straight forward. However, for a closed end instrument, such as a drum, the sound waves are different. A lot of the energy is dissipated through the shell of the drum, which is the reason for the variance in drum construction. Many different kinds of wood are used to generate different sounds or a different amount of energy absorption. The heaviest wood that dissipates the most amount of energy is oak, creating a lower, flat sound. Such observations support the view that indigenous knowledge is expressed in a variety of ways including stories, legends, folklore, rituals, songs, games and even laws (Nyota & Mapara 2008). This information can be incorporated into the Physics curriculum to help learners relate theory to practice.

Sticks and logs were utilized as musical instruments at traditional dances. When a song was started, women with their light voices, men with their deep voices and children with their soft voices joined in the song. The result was a perfect natural combination of voices. Music was formed. Through observations, imitations and practice such physics knowledge was passed from generation to generation even though it was not in written form. Again, some people clapped their hands and stamped on the ground heavily to produced sound during traditional dances. Here, physics knowledge is seen to be disseminated through a hands-on approach as well as being organised in a systematic way. This is succinctly summarized by Charlesworth and Lind (2000) who maintain that concepts are the building blocks of knowledge which allow people to organise information. This preconceived knowledge can be included in the Physics curriculum at a suitable level, thus helping learners to marry theory with practice. A teacher as a facilitator can discuss these ideas with the class prior to carrying out the following experiments on sound:

- To investigate whether sound travels better through solids or gas
- To examine sound vibrations
- To make a hydrophone and examine whether or not sound waves can travel under water
- To make a plastic drum
- To make a rubber guitar
- To make bottle pipes
- To make reed instruments

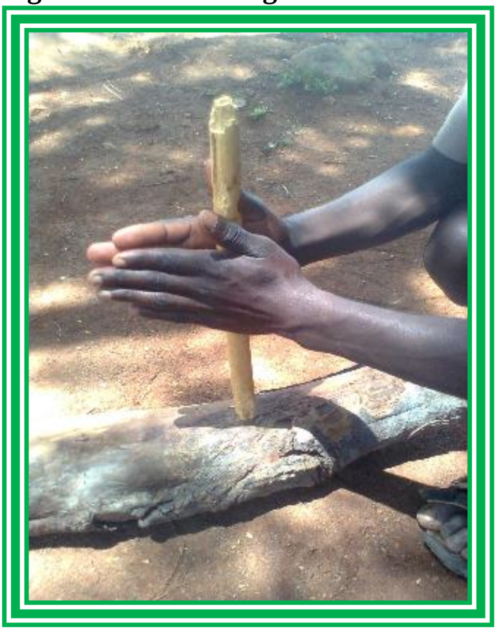
Use of Friction

On a cold day, it is a common practice for some people to rub their hands to generate heat needed for warmth. In the past was friction at play. Heat was also felt in other instances. For example, when two stones hit each other at an angle, sparks were observed. The fire discovery came as result of a need for warmth. It solved the challenges of cold weather. Eventually the need to roast and cook different types of food arose (Sithole in Shizha & Emeagwali 2016).

Additionally, societies knew that friction was a nuisance and had to be removed. The use of rollers was common in different societies to move goods from place to place. Parts of the sleigh was smoothened to reduce friction: hence, the effort required to move the load was significantly reduced. The arrows were sharpened to penetrate faster on shooting the target. Barks were removed from wooden poles and used as rollers to reduce friction and increase mobility. Other objects were roughened to increase the grip. Thus, the soles of wooden shoes were engraved so that they could grip when a person moved. Khupe (2014) indicates that experiences in science are uniquely suited to the development of thinking and problem solving. Thus, the acquiring and usage of friction notions by learners entail both the thinking and problem solving cognitive processes. The indigenous knowledge on friction concepts can be used as prior knowledge such as use of rollers and grease reduce friction. The teacher is encouraged to discuss the preconceived notions on sound before learners do the following experiments:

- How to increase friction
- How to decrease friction
- Friction between rough and smooth surfaces
- Friction between rough and rough surfaces

Figure 5: Fire making method



Source: Photographed by the author (2015)

Food

According to Sithole (in Shizha & Emeagwali 2016), people knew that food in their communities could not last forever and that preservative methods were essential. Meat and vegetables were sun-dried to avoid decay. Thus they knew that moisture had to be evaporated to preserve food.

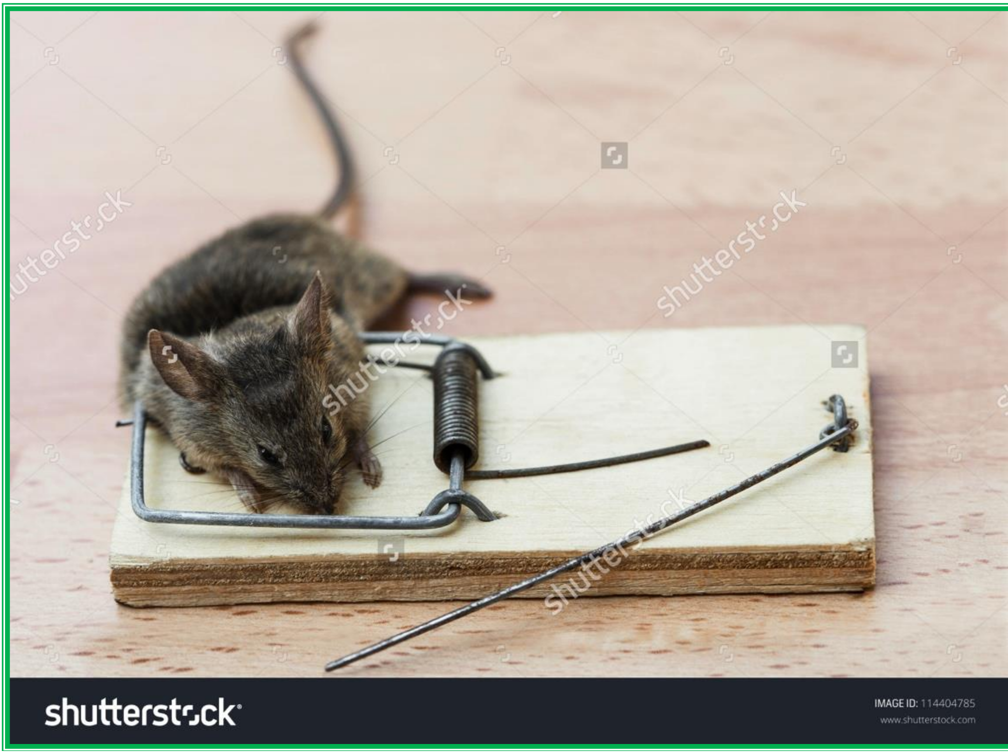


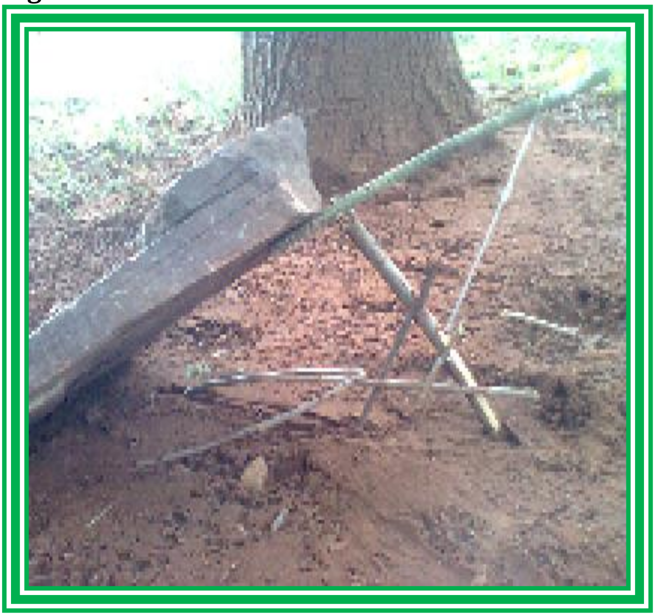
Figure 6: A mouse trap
Source:
https://www.google.co.zw/?gws_rd=cr&ei=qdxsWIntHYfiU7bwjZAO#q =african+mouse+trap+images

Again, people required body building food such as protein. They knew protein had to come from animals and so they devised trapping devices. Indeed, the physics of evaporation of moisture in order to preserve food constitute a significant aspect of indigenous physics per se. The acquisition of such information is interactive physics pedagogy. According to McGrath (2010) scientists such as Albert Einstein believed that in teaching science, learners must interact with materials, collect data and make some order of that data in what they call the learning cycle. Children learn with understanding when the learning takes place in meaningful and familiar situations. For that reason, indigenous physics concepts transfer was done through games stories and play, among many other methods. Such ideas can be incorporated into Physics curriculum. Equally important is to encourage physics teachers to ask learners to construct a mouse trap and then link it to experiments such as the following experiments:

- Hooke's law verification
- Determination of spring constant

Riva

Figure 7: Riva



Source: Photographed by the author (2015)

The 'riva' was used to trap mice, birds and lizards (Sithole in Shizha & Emeagwali 2016). In the 'riva' exists the concept of levers. This did not come from outside but from within. The idea was to enable support survival skills by fulfilling the protein needs of the body. Thus it was imperative to inculcate indigenous physics knowledge in members of the society so they understood the importance of satisfying protein requirements. McGrath (2010) argues that one of the roles of the teacher is to support learners as they move to higher levels of understanding through being engaged in learning experiences. Thus, the riva example can be used in the physics curriculum to help learners conceptualize the lever ideas. The teacher can link the 'riva' concept to lever experiments such as removing objects using crow bars.

Materials and Technology

Figure 8: The hut

Source: Photographed by the author (2015)

An African hut has a round shape. This shape has been maintained because circular shapes resist compression forces through reflecting and spread pressure on their surfaces. The kraals of animals are also circular to resist compression forces. The same principle was applied to block the flow of water in a river. Thus African engineers existed before they were known and acknowledged in the western world (Sithole in Shizha & Emeagwali 2016). In the study of hydrology, some relevant and practical examples can be drawn from locally and naturally acquired physics. It is however understood that the hard mathematical aspect of physics is absent in indigenous physics and should be used to improve the quality of locally acquired physics concepts. Again the circular hut example can be used in an engineering lesson. The teacher may think of reflection scenario in society one of which could be,

- Reflection with mirrors; and
- Reflection water bodies.

The indigenous people made nets to trap fish and wild animals. The net material has strength and the holes in it could not allow passage of certain sizes of animals. Equally significant was the use of clay. The water pot was made of clay. The clay material surface allowed seepage of more energetic water molecules to escape. The less energetic water molecules remained. Hence water was cooled. Thus a large surface area increases the rate of evaporation. Again, keeping water in the pot for a long time caused some bacteria to die. Thus, the water became safe for drinking. The pot was and is used to heat water slowly and to radiate heat fast since black surfaces are good radiators of heat. All such examples serve to show the richness of indigenous physics and that when it is properly taught to student, learning becomes interesting and meaningful. The examples can be incorporated into the physics curriculum.

Measurements

Measurement of distance was evident in traditional African societies (Sithole in Shizha & Emeagwali 2016). The hand and pace were used to determine sizes of meat and fields respectively. There are other means through which measurements are taken. These include the foot size and fixed length of sticks and strings. The precision of the equidistance between circular walls and the maintenance of the circular shape of the walls is an indication of the respect for the mathematical rigors involved in the architecture. This is revealed in figure 10.

Figure 9: Use of hand and figures to record length size

Source: Photographed by the author (2015)

Figure 10: The Great Zimbabwe wall

Source: Photographed by the author (2016)

Temperature was simply defined as being hot and cold or too hot or too cold. The same principle, although it lacks precision, can be used to develop physics concepts such as estimated calculations and measurements. Such societal based methods of recording measurements were learnt in an informal way. According to Mulligan (2003), informal learning experiences are initiated by the adults as they engage children in naturalistic experiences. Such a method of imparting indigenous physics can assist the learner to acquire more complex physics concepts. Therefore the physics educator needs to understand how learners think and learn the concepts and use this information in the planning and structuring experiences for students' learning and in evaluating their learning (Clements 2001).

Colours

Figure 11: Different soil colours

Source: Photographed by the author (2015)

People chose specific soil types to smear their hut floors and walls. Coloured soils were used to paint huts, human faces and wooden plates. Colour is a physics concept and the use of it was known to bring the aspect of beauty

(Sithole in Shizha & Emeagwali 2016). Plant extracts as well as dried ground tree barks of different colours were used to tint baskets, mats and wooden items that were used in the kitchen. The rock paintings seen in national museums and shrines give evidence of the pre-historic existence of indigenous physics in specific societies. People knew how to use it and the occasions appropriate for their use. According to Vygotsky (1978) learning is situated within a particular culture and society which enables knowledge to become contextually defined and relevant. To this end, the utilisation of indigenous knowledge systems in Physics would contribute immensely to the development of the learners as content should be culturally relevant, (Gordon & Browne 2011). Indigenous knowledge of colours has some advantages. One of the advantages is that it is frequently transmitted through the mother language and this maximises concept understanding. The colour concept exists in the Physics curriculum and therefore examples can be drawn from the indigenous knowledge with which some learners are familiar. Lecturers can discuss such useful ideas before conducting an experiment such as:

- Mixing colours and observing the resulting colours

Mechanical Structures

To clamp higher and reach objects beyond their reach, people made ladders. The ladders were placed at an inclined angle. Thus people reasoned that at an inclined angle less effort was used. People moved objects from place to place to make way for cultivations and settlements. The lever idea was used. The lever concept was also used to remove water from deep rivers and wells. Here less effort was used to lift heavy loads. Although such information can be infused in several physics laboratory lessons, research indicates that formal education in some African countries, including Zimbabwe, undervalues the importance of indigenous knowledge (Shizha 2007). In addition, studies have acknowledged the complexities involved in incorporating indigenous knowledge in the school curriculum (Shizha 2006; 2007; 2008; and 2013). The reason for undervaluing indigenous knowledge is that it is mainly oral and not written and easily 'measurable' (Emeagwali 2003). It often has been misrepresented as simplistic and not amenable to systematic scientific investigation.

Thermal Physics

Figure 12: Glass cooling effect

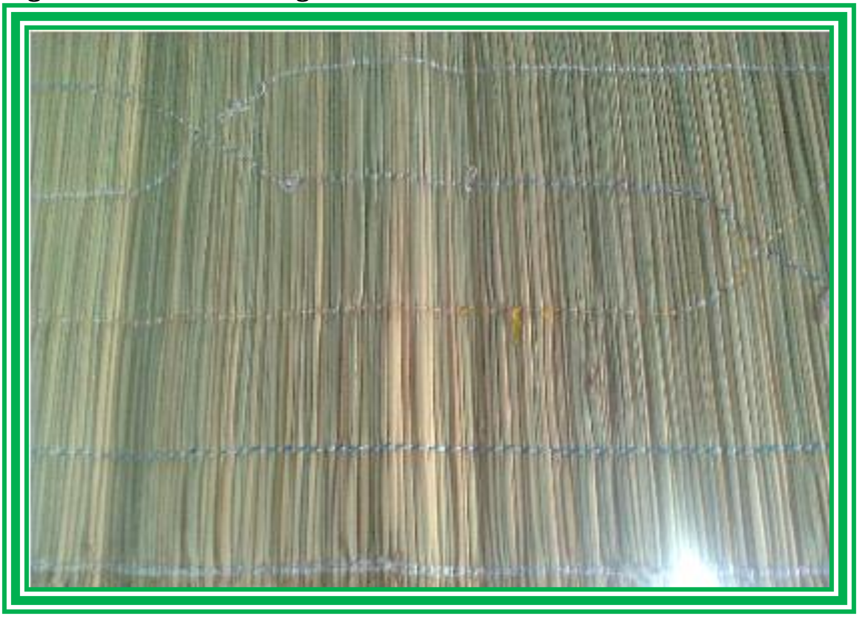
Source: Photographed by the author (2015)

The grass thatched hut as well as a sleeping mat made of reed were cool. Grass (Figure 12) and the reed (Figure 13) are poor conductors of heat. In addition, thatched layers of grass piled on each other do not allow water to pass through during rainfall. The native people also weaved mats using tree fibres and reeds. That was prompted by the necessity to minimise the cold. Indigenous people also made sleeping mats of woven reeds to prevent crawling insects like ants from stinging them (Sithole in Shizha & Emeagwali 2016). It is suggested in this paper that a physics teacher can to link the building and weaving practises described above to the following experiments:

- How conductors are used at home to protect you from injury
- To investigate how the start temperature affects the rate of cooling

- To see how the cooling rate of a water container is affected by the surface area
- To investigate cooling factors

Figure 13: Reeds cooling effect



Source: Photographed by the author (2015)

Sun dried animal hides were also used as mats to sit and sleep on. The use of animal hides prevented crawling and stinging insects. The hide was also used by women to carry babies on their backs. Besides these uses, the hides were used to cover male and female buttocks and private parts.

When people suffered from cold the treatment was simply covering the head with a mat and a hot stone was placed inside a pot with very hot water. The idea was to produce steam which could raise the body temperature of the patient. This resulted in dilation of blood vessels and blood began to flow fast, relieving the patient's discomfort. Likewise, the steam breathed by a patient opened the air passages as well as killing bacteria found in the air passages. Thus it had a healing effect too.

Wood was shaped into plates, spoons and cooking sticks. The most noteworthy tool was ‘rusika’ particle size reducing device. It was used during ‘sadza’ African dish preparation. The concept of reducing particle size to mix completely still stands up to now. It has similar functions in conventional physics. In addition, stones and other available heavy objects were used to crush hard shelled fruits (Sithole in Shizha & Emeagwali 2016). Thus such objects can still be used to perform the same jobs instead of conventional hammers. Similar objects, after they had been sharpened, were used as digging devices. Here the principle of force required to crush objects and to dig the soil in order to get underground roots, was known to the local people as a way of solving environmental challenges. This information can be incorporated into the Physics curriculum. There is a danger that influential people will impose their indigenous knowledge on the local people leading to the displacement of the local people`s existing knowledge (Hewson & Ogunniyi 2011). This is likely to result in loss of crucial indigenous physics before it is recorded.

Gravity

‘Gravity is the force that causes bodies to fall towards the earth’ (Sithole in Bilali *et al.* 199:238). The idea of gravity was observed in African society as in many other societies. People knew that if an arrow is shot upwards, if a stone is thrown upwards, if a fruit falls from a tree branch, and if a person jumps upwards, sooner or later, the destination is the ground. People knew that the lighter the object was, the more time it remained in air. Thus the arrow was made narrow. Pieces of logs used to hit fruits and animals on tree branches had to be made as light as possible (Sithole in Shizha & Emeagwali 2016). Additionally, people observed water flowing from high ground to low ground by means of gravity. Such was indigenous physics. It is however correct to observe that there are several pitfalls in indigenous physics. The mathematical rigours needed in the further illustration of physics concepts are absent. One of the reasons the development of physics in many societies has been slow is the seemingly imposed abstraction by conventional physics in which learners are obliged to follow a formulaic physics perception. In view of examples cited above, it can be concluded that indigenous physics has a role to play in conventional physics. The reason is that indigenous African physics, as in other societies, increases and broadens learners’ abilities to be innovative, imaginative, and creative. Nevertheless, Horsthemke (2008) appears to suggest that such indigenous knowledge involves at best an incomplete, partial or, at worst, a questionable understanding or conception of knowledge; and indigenous knowledge is largely inappropriate. This implies that indigenous knowledge such as Physics is viewed as not being complete without external influence and knowledge. The fundamental premise of this paper is not that indigenous knowledge is infallible but that the ideas with which learners are familiar should be incorporated into the Physics curriculum.

Oxygen Supply

Mvuto (an oxygen supply device) was used to keep fire burning when extracting iron from iron ore. Supplying oxygen using the mouth was a tiresome process and was replaced by the mvuto device. Today the same device can be used in the laboratory in the reduction of copper ore and iron ore. The information can be incorporated into the school Physics curriculum to help learners marry theory with practice.

Seiving Device

Figure 14: Sieve mat 'tsero/hluzo'

Source: Photographed by the author (2015)

According to Sithole, the sieve mat made out of either the reeds or the bark fibre was used for separation of beer, honey and milk substances from their mixtures by a filtration process (in Shizha & Emeagwali 2016). It acted as a sieve. Again, the fractional distillation method was used to separate substances before it was made public in written form. Thus the society had distilled beer. The wind was also used to separate seeds from chaff. The same principle can be used in laboratories located in remote area where the traditional laboratory equipment is scarce. Here it can be argued that indigenous physics which learners experienced at home can help the same learners to understand conventional physics. For that reason indigenous Physics should be incorporated into the Physics curriculum.

Ash Usage

Ash was used for the sedimentation of dust particles in water. This is parallel to the process of settling dust particles in water using aluminium sulphate in water works. This can be taken as assumed knowledge in a conventional physics lesson. That is the knowledge learners bring to the laboratory and the physics teacher can take advantage of such preconceived knowledge. This will enhance learning.

Cooling Effect In Heat

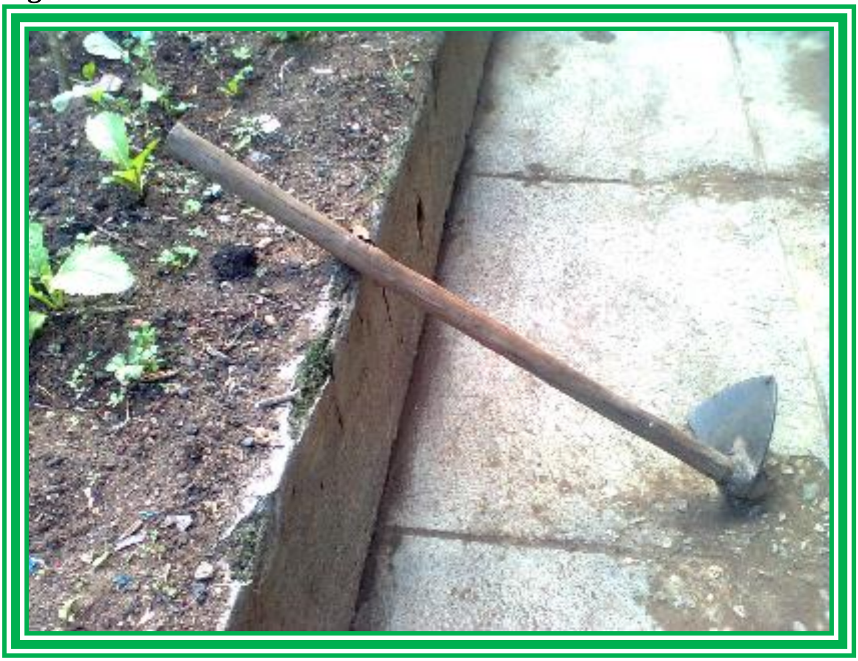
Figure 15: The roof structure

Source: Photographed by the author (2015)

Ceilings made out of reeds trapped air (Sithole in Shizha & Emeagwali 2016). Air is a poor conductor of heat. This made the rooms cool. The modern ceiling board uses the same principle. So learners' experiences on cooling can be used in the physics lesson.

Turning Effect in Moments and Mechanical Structures

Figure 16: The hoe handle

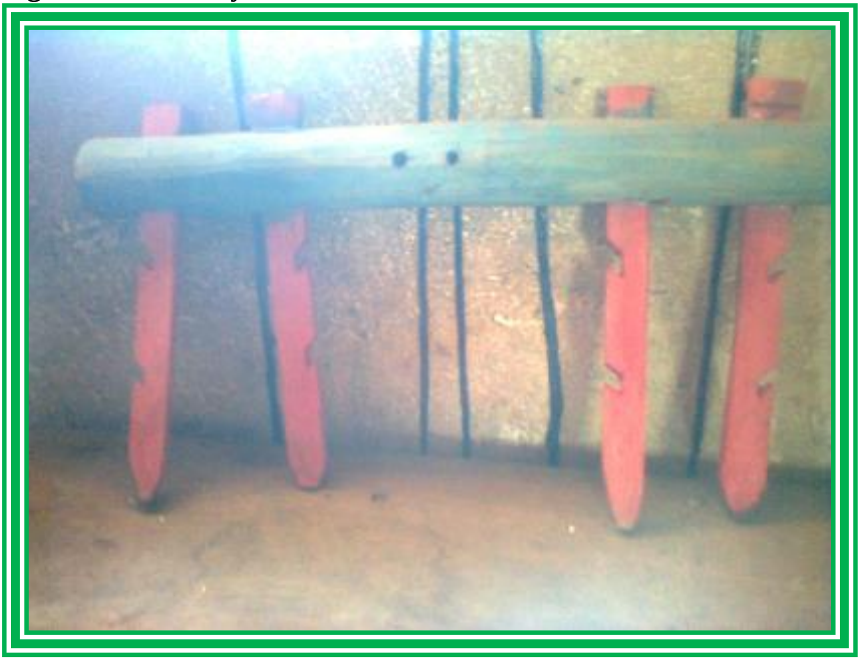


Source: Photographed by the author (2015)

The long handles on hoes and axes reduced effort used. Another example is the use of crow bars which was used to make work easy. The same principle is still being used in the contemporary physics (Sithole in Shizha & Emeagwali 2016). The position of house door and car door handles to name a few examples serve to illustrate the application of the turning effect in everyday situations. So the indigenous physics works very well and can be incorporated into physics syllabi.

Balance

Figure 17: The ox yoke



Source: Photographed by the author (2015)

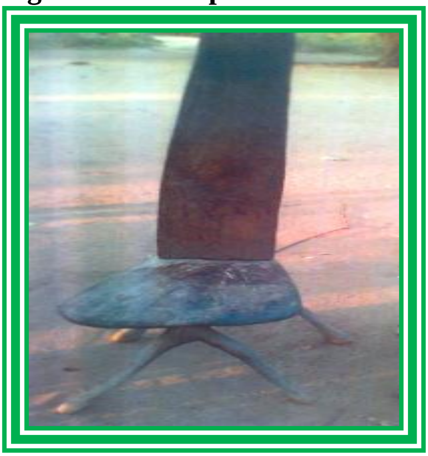
Another illustration of indigenous physics is manifested in the ox yoke shown in figure 17 above. The head rest wooden pillow is another good example which can be used to demonstrate the idea of head balance. The different types of wooden stools also illustrate sense of the physical balance. The fire place had three stones to give support to the pot. Again this indicates the sense of equilibrium and balance. Examples drawn from such experiences can be used in the conventional physics laboratory. Some experiments which can be done to link learner prior existing knowledge to conventional physics are:

- How to balance a pencil on its tip;
- Defying gravity while balancing forks; and
- How to balance a potato.

Figure 18: Stool parts dismantled

Source: Photographed by the author (2015)

Figure 19: Stool parts assembled



Source: Photographed by the author (2015)

The above images (Figure 17 and Figure 18) indicate that local people made use of locally found resources for particular functions. . The photo images also serve to prove that the concept of problem solving was an important survival skill which was inherent in indigenous people globally. However, it was locally centred since specific areas had unique challenges and resources. Learners can be helped to acquire design experimental skills when they practise to assemble apparatus before being engaged in Physics lesson experiments. For this reason this exercise can be incorporated into Physics syllabi as experiments and tutorials.

Use of Games as a Physics Teaching Approach
Figure 20: Tsoro yemutatu (The three piece game)

Source: Photographed by the author (2016)

Problem solving skill of avoiding defeat was embedded in all aspects of indigenous physics. The 'tsoro yematatu' game was quite often played by men to enhance thinking skills (Sithole in Shizha & Emeagwali 2016). Pupils played 'mudodo' (Figure 20) to instil competitive skills, as well as managing stress caused by defeat. Not only did the two games develop problem solving skills, they instilled counting. Counting is one of the physics process skills in contemporary physics. These can be incorporated into the Physics syllabi as experiments and tutorials.

The Floating Ability of Wooden Boats and Rafters

Ancient fishermen used logs of wood to construct boats. Wood is a material which is less dense than water. For this reason, wood floats in water. Thus the floating ability of wood was known in ancient times. It indicates the application of the principle of buoyancy. Some indigenous people designed and built boats out of wood that would float in water, and then refined their designs so that their boats would carry as great a load (in some instances fish or even people) as possible. Building a wooden boat to hold as much weight as possible was an engineering design problem. The use of equipment in the laboratory to illustrate indigenous application of conventional physics concepts is therefore justifiable. Vygotsky (1978) argues that development and learning is strongly entrenched in culture. Culture is the people`s total way of life, their food, knowledge, norms and values (Giddens 1993). Hence, Vygotsky`s theory becomes important in informing the argument that indigenous knowledge is embedded in a given community's way of life, such as fishing activities, and indigenous flotation knowledge becomes an essential part of learners' physics courses. Some of the experiments which have a linkage to what some learners already know are:

Floatation Experiments

- To do an ***experiment*** to see which of the objects sink down when they are placed into water and which ones ***float; and***
- ***Floating eggs in salt water experiment.***

Tension and Compression Strength of Materials
Figure 21: Use of hand and figures to record length size

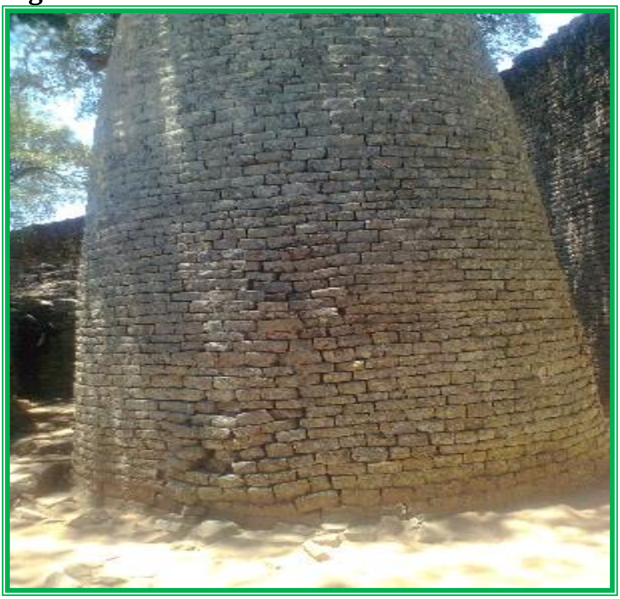
Source: Photographed by the author (2016)

A closer look at Great Zimbabwe reveals the physics nature of indigenous knowledge. What is amazing is the remarkable similarity between past construction structures and those used in our daily lives. Indeed, today builders put reinforced concrete on door and window frames to withstand tensile and compressive forces. In the past, indigenous people typically chose wood or stone bars and placed them at ingress and egress points as indicated by figure 20. This indicates the creative design capacity of of indigenous physics.

The Conical Tower at Great Zimbabwe

The exact identity of the Great Zimbabwe builders is still a matter of debate. However, the majority of scholars believe that it was built by members of the Gokomere people , who were ancestors of the modern Shona in Zimbabwe. Whatever the case might be, there was notable mathematical intelligence in the construction of the conical tower by indigenous inhabitants of Great Zimbabwe. This reinforces the notion that learners are not blank slates upon which knowledge should be etched. The wisdom we get from the past construction of such a remarkable structure provides evidence that learners should be allowed to apply what they already have in their minds to new knowledge. The construction of the conical tower is such that it clearly points to indigenous people who thought like physicists and mathematicians. Mathematics as the language for physics such as that used to design the conical tower.The remarkable fact is that the values of these numbers seem to have been very finely adjusted to make possible the construction of the conical tower at Great Zimbabwe.

Figure 22: The conical tower



Source: Photographed by the author (2016)

From the foregoing scenarios the following aspects of indigenous physics learning can be deduced and recommended:

- Learners construct their own understanding and knowledge of the world through their experience and through and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and experiences,
- The teacher makes sure she understands the students' pre-existing conceptions, and guides activities designed to address them and then build on them.
- When they continuously reflect on their experiences, learners find their ideas gaining in complexity and power, and they develop increasingly strong abilities to integrate new information with preceding information.
- The teacher is encouraged to prompt each learner to reflect on and examine his or her current knowledge.
- The teacher should talk about what learners have learned, and how their observations and experiments helped (or did not help) them to better understand the concept. This helps learners to construct knowledge rather than to reproduce a series of facts.
- Always guided by the teacher, learners construct their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.
- Learners become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings.
- Learners are not a blank slate and knowledge cannot be imparted without the recipient of new knowledge making sense of it according to his or her current conceptions. Therefore, learners learn best when they are allowed to construct a personal understanding based on their experiences and reflecting on those experiences.

Rationale for Teaching Indigenous Physics in Schools

What becomes apparent is the amazing resemblance between indigenous physics and some of the insights that are emerging from modern physics. There is a congruence that is as enlightening about the physical universe as it is about the circular evolution of man's understanding. Physics teachers and lectures can draw on indigenous African knowledge as they teach concepts and introduce terminology and nomenclature in the physics curriculum **(**Abiodun 1998).

The question often asked is: What is Indigenous physics? It is a large body of physics knowledge and skills developed outside the formal education system in pre-colonial societies. However one can argue that physics is physics. In this world we live in, the teaching of physics must comply with international standards that are accepted by the international community. If learners are to compete in the global job market they must learn the universally appropriate, acceptable technology and engineering, to cite two examples of physics concepts. Thus, to all intents and purposes, learners need to be taught physics subject concepts properly.

Localized and societal oriented physics has been mistakenly associated with 'cultural' physics. This perspective ignores that culture permeates everything we do. According to Ngara (2007) indigenous knowledge system complexities are found in community ceremonies and rituals which include story-telling, proverbs, folktales, recitation, demonstration, sport, epic poetry, riddles, praise songs, word games, puzzles, tongue-twisters, dance, music, beliefs and other education-centred activities. According to Ken (2009) we do not fully know the world directly but perceive it through frameworks of ideas and beliefs, which act as filters on what we see and how we see it. This includes physics concepts taking into account the integrated nature of knowledge that society acquires and transfers.

Within a constructivist approach to learning physics, prior knowledge has been found to underpin learning in a significant way – either as a hindering or helping factor. It is hindering in the sense that one can feel crippled in one's ability to indigenise Western acquired knowledge and skills within the African cultural context (Nsamenang 1995). Again, the tendency to adhere to Western tools and methodologies in African research could be one hurdle in the process of indigenisation and integration (Azuma 1984). Educators should take such problematics into consideration when planning what indigenous physics knowledge to teach to physics learners as prerequisites to their comprehension of western and internationally recognized physics.

Equally significant is what research has shown. One key issue that affects learning of physics in Africa has been the controversial status of prior knowledge that learners bring into the classroom. When they come to school, they bring with them built up knowledge about what they will be taught. Hence, to say that precolonial African societies had no sense of education and therefore no education is not only a mockery but also a gross misrepresentation of facts (Mapara 2009). According to Mapara, African indigenous education had utility value. Youngsters were taught skills such as hunting, fishing, fish traps, and hoe handle making. Nevertheless, he acknowledges the significance of Western knowledge by arguing that indigenous knowledge system researchers must not negate existing Western methods of investigation. Mapara (2009) argues that IKS researchers must respect all forms and sources of knowledge. This is because each methodology, however seemingly different, can add value and enhance the process of creation of new knowledge as each provides insights and tools which enable perception and interpretation of the world.

The debate highlights that indigenous physics exists in its own right; it does not need to explain itself to anyone such as the western knowledge system advocates. It therefore needs no justification outside itself. Furthermore, indigenous physics presents a valid understanding of nature in its own right. It does not employ experiment in the scientific Western sense. The indigenous physics dealt with connections, harmony and relationships rather than with mechanical influence on forces on bodies. People were and are able to make use of certain processes in order to bring desired results. The stress is laid upon direct objective experience and upon closeness to nature. The application of physics principles in the development of our indigenous technologies will help in the productions of more valuable goods that conform to modern standards and can be marketed beyond our traditional communities (Abiodun 1998), succinctly stressed.

In addition, Gallenstein (2003) emphasises that the physical environment created by teachers for learning have implications for learners' involvement and interaction. Therefore for learners to effectively acquire physics concepts, the learning environment should have the following features:

- provide resources that encourage active learning, involvement, negotiation and collaboration;
- consider learners' cognitive abilities, emerging social skills and provide sufficient resources to alleviate disputes while at the same time assisting learners to negotiate with their peers;

- provide opportunities for learners to make choices and provide sufficient resources that are accessible to learners. This procedure empowers learners to be in control of their own learning and to become deeply engaged in learning experiences;
- provide on-going experiences using learning projects to facilitate in-depth investigations and promote collaborative learning; and
- expose learners to science experiences that provide appropriate levels of challenge and provide the teacher's guidance to promote success and build feelings of competence.

Physics educators need to be resourceful and be ready to answer a wide range of questions that arise from physics learners. The teacher should have the following aims in mind, which assume learner experience knowledge of indigenous knowledge:

- To arouse learners' curiosity and interest in the world around them.
- To help learners develop their observation and discovery skills.
- To help learners develop the required science language that enables them to develop and record their observations, clarify their findings and to describe their discoveries accurately.
- To help learners develop appreciation for use of science in their daily lives.

The Importance of Including Indigenous Physics

The importance of indigenous knowledge systems is supported by the United Nations article 14 (1) (2007) which argues that indigenous people have the right to establish and control their education systems and institutions in a manner appropriate to their cultural methods of teaching and learning. Chisholm (2005) cites critics such as Muller (2000; 2001) as arguing that education that focuses on the local, known and every day is not education, for at the heart of the instructive effort is a leading away from the known, familiar and every day into universal processes. However, the debate indicates that Westerners succeeded in imposing knowledge developed in the west on local people, thus displacing the local people`s existing knowledge (Hewson & Ogunniyi 2011). It can therefore be argued that indigenous knowledge existed in both western and non- western worlds, and that while indigenous knowledge has not achieved universal status it nonetheless still exists among different ethnic groups in Zimbabwe, in particular and other societies in general.

In a nutshell, Khupe (2014) argues that if the motive for indigenous knowledge (physics) is inclusive, then all indigenous knowledge (western and non-western) should be taken into consideration since not to do so defeats the principle of inclusion. The debate on indigenous knowledge recognises the importance of the learning context which is fertile ground for indigenous knowledge as a way to make learning relevant and avoid discord between what is learnt in school and everyday life (Khupe 2014). Khupe's (2014) argument supports the contention that indigenous physics has a significant role in the conventional physics laboratory.

Indigenous knowledge is relevant to a particular society; it forms part of global knowledge, and should be recognized, valued and appreciated. It should be preserved, transferred, adopted elsewhere. A sound understanding of indigenous knowledge is needed. African IKS are critical components in the quest for the provision of quality education for all (Mapara 2008).

Conclusion

In conclusion, reiterating earlier points, the term Physics refers to the study of matter and energy in its different forms, and the transformation of matter and energy. Indigenous physics may be perceived as a way of knowing and a way of life which is experienced by members of a given society. The discussion also highlighted the fact that physics teachers and lecturers can draw on indigenous African knowledge as they teach western based physics concepts.

The article explores the capacity of indigenous physics knowledge to promote social development. The exploration was undertaken in order to emphasise that it is time to see the necessity for the curriculum development planners to take into account accumulated indigenous knowledge and traditional skills. This is because indigenous physics knowledge, whether institutionalized or not, structured or unstructured, has specific implications for democratization, community empowerment and nation building.

Equally significant is the notion that indigenous physics knowledge should not be distorted, trivialized and neglected by western education. Instead, it should be preserved, transferred and adopted since any form of knowledge is meaningful only within its own cultural situation. Indeed there should be shared meanings which are key factors in binding people and societies together as vehicles of social cohabitation (Mapara 2009). The application of physics principles in the development of our indigenous physics related technologies will help in the productions of more valuable goods that conform to modern standards and can be marketed beyond our traditional communities. The discussion also indicated the inclusive nature of indigenous physics knowledge systems. Indeed, contributions of indigenous physics to recognition of the passions and interests of different members of society cannot be overemphasised. To support such a standpoint, a few examples of prominent individuals and their revolutionary innovations were mentioned.

Finally, the intention of this paper is to show that poor analysis of indigenous physics knowledge systems threatens traditional knowledge with dispossession and carries the risk of distorting such systems in the process. For this reason indigenous physics knowledge makes sense only within its own cultural context. Also emphasised in the paper is that modern science can gain a lot from indigenous physics knowledge systems. This is demonstrated in the paper by examples showing application of indigenous physics concepts in a cultural setting which could be used to enhance African student's appreciation of Physics. Indeed, Physics experiments could be developed from practical situations in African students' cultural environments. We must change our position and start embracing indigenous physics into the curriculum. There is need to demystify the notion that indigenous physics knowledge systems are by definition unscientific. There is no doubt that a parallel exists between indigenous physics and conventional physics learnt at school. We should not scoff at indigenous physics, but admit that it plays a part in existing conventional physics.

References

Abiodun, J.O. 1998. *Indigenous Knowledge and Sustainable Development in Nigeria*. Ibadan: University of Ibadan Press.

Berk, L. 2010. *Child Development*. 8th Edition. London: Pearson.

Bilali, S. *et al*. 1999. *Longman Science 1*. Australia, Melbourne: Longman.

Cambridge University Press 2016. Meaning of 'Indigenous' in the English Dictionary. Available at: http://dictionary.cambridge.org/dictionary/

english/indigenous. (Accessed on 9 August 2016.)
Charlesworth, R. & K. Lind 2010. *Maths and Science for Young Children*. New York: Wadworth.
Chetty, N. & N. Comins 2002. Perspectives on Physics and Industrial Development. *Phys. Scr***.** Available at: http://iopscience.iop.org/1402-4896/2002/T97/034. (Accessed on 04 August 2016.)
Chisholm, L. 2005. The Making of South Africa`s Revised National Curriculum Statement. *Journal of Curriculum Studies* 37, 2: 193-203.
Clark, L. H. 1997. Science and Technology in Akwa Ibom State: Visions and Perspective Experience. *The Science Teacher* 49, 4: 24-25.
Clements, D.H. 2001. Mathematics in the Pre-school. *Teaching Children Mathematics* 7, 5: 270-275.
Flavier, J.M. 1995. The Regional Program for the Promotion of Indigenous Knowledge in Asia. In Warren, D.M., L.J. Slikkerveer & D. Brokensha (eds.): *The Cultural Dimension of Development: Indigenous Knowledge Systems*. London: Intermediate Technology Publications.
Gallenstein, N.I. 2003. *Creative Construction of Mathematics and Science Concepts in Early Childhood*. Olney, M.D: Association for Childhood Education International,
Giddens, A. 1993. *Sociology*. Cambridge: Polity Press.
Golbeck, S.L. & H.P. Gunsburg (eds.) 2004. Early Learning in Mathematics and Science. *Early Childhood Research Quarterly* 19, 1: 190-200.
Gwekwerere, Y. 2016. Schooling and the African Child: Bridging African Epistemology and Eurocentric Physical Sciences. In Shizha, E. & G. Emeagwali (eds.): *African Indigenous Knowledge and the Sciences. Journeys into the Past and Present: Anti-colonial Educational Perspectives for Transformative Change.* Rotterdam, Netherlands: Sense Publishers.
Hewson, M.G. & M. B. Ogunniyi 2011. Argumentation-Teaching as a Method to Introduce Indigenous Knowledge into Science Classrooms: Opportunities and Challenges. *Cultural Studies of Science Education* 6: 679- 692.
Horsthemke, K. 2008. The Idea of Indigenous Knowledge. *Archaeologies Journal of the World. Archaeological Congress* 4,1: 130-141.
Katherine T. 2013. A Framework for Curriculum Reform: Re-designing a Curriculum for Self-directed Language Learning. *Studies in Self-Access Learning Journal* 4, 2:142-153.
Ken, R. 2009. *The Element: How Finding Your Passion Changes Everything*. New York: Penguin Books.

Khupe, C. 2014. *Indigenous Knowledge and School Science: Possibilities for Integration.* Johannesburg: University of Witwatersrand.

Macaulely, D.K. 1989. *A Survey on Indigenous Technology and Its Science Implication. B.Sc. Project.* Port Harcourt: University of Port Harcourt:

Mapara, J. 2009. Indigenous Knowledge Systems in Zimbabwe: Juxtaposing Post-Colonial Theory. *Journal of Pan African Studies* 3,1: 139-156.

McGrath, C. 2010. *Supporting Early Mathematical Development. Practical Approaches to Play-Based Learning*. New York: Routledge.

Nyota, S. & J. Mapara 2008. Shona Traditional Children`s Games and Play: Songs as Indigenous Ways of Knowing. *Journal of Pan African Studies* 2, 4: 189-202.

Sabinet 2015. Indigenous Knowledge Systems and Academic Institutions in South Africa. Available at: http://reference.sabinet.co.za/sa_epublication_article/persed_v19_n1_a6 Retrieved on 04/03/15. (Accessed on 09 August 2016.)

Shizha, E. 2006. Legitimizing Indigenous Knowledge in Zimbabwe: A Theoretical Analysis of Post-Colonial School Knowledge and Its Colonial Legacy. Paper 2. *Youth and Children`s Studies in Education* 1,1: 20-35.

Shizha, E. 2007. Critical Analysis of Problems Encountered in Incorporating Indigenous Knowledge in Science Teaching by Primary School Teaching in Zimbabwe. *Youth and Children`s Studies* 53, 3: 302-319.

Shizha, E. 2008. What is Indigenous Knowledge in Zimbabwe? Beliefs and Attitudes of Rural Primary School Teachers. Towards Indigenous Knowledge in the School Curricula in Zimbabwe. *Youth and Children`s Studies* 2: 234-342.

Shizha, E. 2013. Reclaiming Our Voices: The African School Curriculum Problem with Post-Colonial Sub-Saharan Africa. *Journal of Indigenous Social Development 2*:1: 1-18.

Shizha, E. 2016. African Indigenous Perspectives on Technology. In Shizha, E. & G. Emeagwali (eds.): *African Indigenous Knowledge and the Sciences. Journeys into the Past and Present: Anti-colonial Educational Perspectives for Transformative Change*. Rotterdam, Netherlands: Sense Publishers.

Sithole, M. 2016. Indigenous Physics and Academy. In Shizha, E. & G. Emeagwali (eds.): *African Indigenous Knowledge and the Sciences. Journeys into the Past and Present: Anti-colonial Educational Perspectives for Transformative Change.* Rotterdam, Netherlands: Sense Publishers.

Stavy, R. & D. Tirosh 2000. *How Students Misunderstand Science and Mathematics: Intuitive Rules*. New York: Teachers' College Press.
The world Bank Group 2016. What is Indigenous Knowledge? Available at: http://www.worldbank.org/afr/ik/basic.htm. (Accessed on 09 August 2016).
UN. 2007. *The UN Declaration on the Rights of Indigenous Peoples*. New York: United Nations.
Vygotsky, L. S.1978. *Mind in Society: The Development of Higher Psychological Processes*. Cambridge: Harvard University Press.
Warren, D.M. 1991 *Using Indigenous Knowledge in Agricultural Development.* World Bank Discussion Paper No.127. Washington, D.C.: The World Bank.
Wikipedia Feb. 2016. *Physics Education*. Available at: https://en. wikipedia.org/wiki/Physics_education. (Accessed in August 2016.)
WordPress 2011. *What is Physics?* Available at: http://whatisphysics.org/ (Accessed on 9 August 2016).
Worldwide Indigenous Science Network 2013. What is Indigenous Science? Available at: www.wisn.org/what-is-indigenous-science.ht (Accessed on 9 August 2016).

Mathias Sithole
Physics Lecturer: Department of Science and Mathematics
Marymount Teachers' College
Zimbabwe
mathias_sithole@yahoo.com