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Integrating indigenous knowledge into chemistry and science education

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***Abstract*—** This paper uses abstract and material evidence to highlight the nexus between Western-made science and African Science. After this, the paper highlighted some of the limitations of both. It advocates the integration of indigenous knowledge into science teaching, most especially in chemistry.

Keywords: Effective Teaching and Learning, Rural Schools, Teachers' Self-Efficacy, COVID-19 Pandemic

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I. INTRODUCTION

INDIGENOUS knowledge of the African is defined as the African way of knowing (Jegede, 1997). African indigenous knowledge has witnessed varying responses since the maiden contact between the custodian or users of such knowledge and Western science and science education. The younger generation of Africans who had the first contact with Western education had an attitude of rejection of what had sustained the African society. This younger generation's reaction and attitude made the custodian regard them as unworthy recipients of detailed knowledge transfer. This has largely reduced the level of acceptance of the knowledge of African indigenous people over time.

However, these negative reactions cannot erase technological and scientific discoveries and research exploits done through African indigenous knowledge. For instance, several archeological discoveries are globally acclaimed proof that African indigenous knowledge has developed several meaningful devices and processes for the development of mankind long before Western science came to the limelight. Ssereo (2012) claimed that his first chemistry lessons were not in a classroom with trained teachers but with an aunt who had never studied chemistry but brewed the best Waragi (traditional alcohol in Uganda). Ssereo (2012) stressed that his aunt not only brews alcohol but also controls the quality by burning small samples while the distillate is still very hot. The sample with a clean blue flame is considered the purest by the aunt, who never went to school.

Unfortunately, irrespective of the productive nature of indigenous African knowledge in science in which chemistry is inclusive, African indigenous knowledge has suffered huge marginalization and devaluation (Shiza & Emeagwali, 2016). There is no contention that African indigenous knowledge has existed for centuries and generations. It has also been sustainably utilised to serve African communities and societies.

II. LITERATURE REVIEW

Literature reiterated that all forms of science depend on cultural practices and direct observation, experience, experimentation, and interpretation (Jegede, 1997; Aikenhead, 2001; Shiza & Emeagwali, 2012). This is also affirmed by Aikenhead (2001) and Akpan (2010), who states that every culture, including Africa, has some science, and science is a local commodity designed to satisfy local needs and solve local problems. Reflecting on the similarity of the nature of African and Western science will create a sense of appreciation for African science and make stakeholders consider it a viable resource for Chemistry education.

Nexus between the Western and African Science

Although there are differences between the two sciences in terms of knowledge creation, knowledge transmission, and ownership of knowledge, they still have some similarities. From the social point of view, Richter (1972) conceives science as a cultural process. This definition indicates that science usually has the coloration of the culture from which it emerges. This means that every culture has science, although it may not have the nomenclature "Science" which has gained popularity because it has emerged from the European culture (Akpan, 2010). Scientific knowledge is the trade in stock in science, and it is usually a product of high-level explanations that are generalizable and verifiable by experiments.

Unfortunately, Western scientists consider African science inferior because they did not find Africans using mechanical gadgets like radio, televisions, and books when they came (Ogunjimi & Na' Allah,2005). These gadgets are mere products of an intellectual mind, not vice versa. The creative process in the minds of our ancestors has produced so many things worth considering. For example, evidence found at Wonderwerk cave in South Africa reveals that for more than 100.000 years before it was eventually discovered, Africa had developed the capacity to mix paints in the container in the form of Abalone shells to coat their ornaments with iron oxide pigment (Emeagwali & Shizha, 2016). This shows the ethno-chemistry knowledge of the ancient African men and the products they could come up with.

Similarly, the iron-making industry was already thriving in Africa before Africans contacted Western science. Tanzania had a spectrum of expertise in steelmaking (Schmidt, 1997). Time will fail to highlight the exploits of ancient Nubia, Ghana, Mali, Songhay, Mapungubwe, Zimbabwe, and Nigeria in the areas of use of furnaces, African metallurgy, gold mining, and Jewel making (Okafor, 2004). Indigenous

science and science education thrived before the dominance of Western, Eurocentric scientism (Emeagwali & Shizha, 2016). Beyond evidence related to chemistry, African indigenous scientific knowledge, like Western science, succeeded in medicine, geology, physiology, biology, and agronomy.

One of the purposes of this study is to advance the narrative of the strength and exploits of indigenous African science beyond anthropological and archeological evidence. The Eurocentric Western science has its epistemology. This epistemology guides all the activities of the scientist. The African indigenous science (Chemistry) has her epistemology. The difference is that the epistemology of African Indigenous Science is embedded in the holistic worldview of Africans. A critical look at the African oral literature provides information on what has aggregated as their cultural beliefs, mores, institutions, artifacts, and practices not yet contaminated by the complexities of modern societies. We can also deduce the epistemology of African science from the African oral literature (Jegede, 1997).

For example, the critical aspect of the epistemology of science is the values or attitude of science. One of these attitudes is the tentativeness of scientific knowledge and method. For example, the understanding of the atom started with the Dalton solid sphere model, and as soon as Thompson brought the plum pudding model forward, the Dalton model was jettisoned. Later, Rutherford's Nuclear model replaced the Thompson model. Also, in 1913, Bohr proposed his quantized shell model, which provided a better explanation of the nature of atoms. In 1926, Schrodinger's quantum model offered a superior explanation of atoms.

Similarly, a Yoruba proverb says that Ọgbọ́nọdúnnìí, Òmùgọ̀ ẹ̀mí̀ì. This simply means what we regard as knowledge, intelligence, or wisdom this year or presently will amount to foolishness next year or in the future. Dalton's solid sphere atomic model was acceptable in 1803 but unacceptable in 2019. The Yoruba people will say to anyone who is not accepting a new model, " àgbọ̀nrín èsí lòńjẹ lọ́bẹ̀" (eating the deer hunted last year in the soup). Hence, just like the Western scientist, the African scientist accepts that all scientific knowledge is open to re-evaluation in the light of new information.

Furthermore, Taber (2017) asserts that the essence of science is the development of explanatory schemes that make sense of an extensive volume of data and have predictive value. In the view of Taber, scientific enterprise must continuously provide a verifiable explanation of nature. Hence, western science has its products. The products of science include laws, principles, theories, and hypotheses, to mention a few. The African scientists in ancient times did the same. However, their science products are documented in the oral literature of the Africans. Most of the lines of incantatory poetry and African proverbs can be equated to the Western product of science. Omilani (2019) concluded that African proverbs that delve into science and logic offer causal explanations of natural events like Western science. Ogunjimi and Na'Allah (2005) reiterated that logic and science are integral to the intellect, wisdom, and strong psychic vision inherent in African proverbs and other oral forms. For example, when they say 'èéfín nìwà' (the human character is like a smoke) or 'Kánkán loró iná ń múgí' (the combustion rate of wood is faster). The first statement depicts many things related to the principle of diffusion and the kinetic theory of gases (Omilani, 2019). The second one also explains the rate of the chemical reaction (combustion of wood compared to other materials).

Finally, Western science has a specific way through which it tests its ideas by doing experiments that will prove or falsify them (Taber, 2017). In recent times, several sophisticated apparatuses have been used for experiments. Also, observational experiments may be carried out. This is not new to the ancient African scientist. For example, one of their proverbs says, 'Ojú làá mọọbẹ̀ tí kò lépo, ìtọ́wò làá mọèyí tí kò níyọ̀' (through observation we can determine a soup without oil, but the one without salt can only be determined by taste). The implication of this is that the suitability of the method used is crucial to the experiment of the African scientist. In chemistry, some properties of matter are in the macroscopic observable realm. Examples are precipitation, the enthusiasm of gases, and precipitate formation. All these are in the realm of physical observation. Chemical tests, on the other hand, require testing samples with reagents. The tasting of the soup to the African man shows that salt is a submicroscopic property, and a chemical test is necessary. Science process skills are usually developed from being a novice to a level of expertise. A certain Igbo proverb says, 'Ada amu aka, ekpenanka' (You do not learn to use your left hand in old age). This means there is an agreement between African science and Western epistemology regarding acquiring science process skills.

Limitation of Western Science and Indigenous African Science

Western science is not without its limitations. Taber (2017) explained that it is difficult to reduce the description of everything in the natural world in terms of particles, forces, and energy. Also, experimenting in space science regarding the constellation is impossible. Many of the negative labels Eurocentric scientists give indigenous African science are largely because when African indigenous science cannot explain a natural phenomenon, it attributes it to spirituality (Akpan, 2011; Amzat, 2019). It is not inaccurate for Western scientists to have such a view of African science, especially when there is a disparity between the Western and the African view of the universe. It is important to note that the African Universe does not exclude spirituality and mystic-religious methods (Jegede, 1997; Akpan, 2011).

Without any hesitation, it is the interest of this study to clarify that some African indigenous explanations, which are usually considered mystic-religious by Western science, may have some elements of science in them. For example, African indigenous science is confident that when powdered herbs are sprayed on the solid waste of a hemorrhoid patient, the hemorrhoid will be cured. Western science will raise questions like how come the herb that was not consumed cures hemorrhoids that are within the lower section of the gastrointestinal tract. However, the African science practice and knowledge may be like what classical physics (western science) considers as action at a distance. According to Popkin (2018), two particles that are light years apart affect each other as though there is a mysterious communication channel between them. This is what Einstein refers to as quantum entanglement. Issues related to using laser impulses to achieve the vibration of a micrometer-long silicon chip and Heisenberg principles also show some phenomena that can only be observed but not explained. The principle states that accurately determining an electron's position and speed is impossible. Having laid out the rationale for accepting African indigenous knowledge, this study will outline how aspects of indigenous knowledge related to chemistry can be integrated into the classroom.

Integrating Indigenous Knowledge into Chemistry and Science Education

The worldview of an African child differs from that of a European child. Therefore, any chemistry learning experience void of the African child's worldview will produce a learner knowledgeable in chemistry (Western) but cannot easily use the knowledge to transform his immediate environment. Aikenhead (2001) highlighted that integration of the Aboriginal worldview into the science curriculum depicts many benefits inherent in such approaches. Leading among them is contextualised learning in a bilingual way.

Contextualized chemistry classrooms will allow African children to compete globally and be agents of change in their communities. Advocates of science education that inculcates indigenous knowledge argue that this approach demystifies science as a complex subject and makes it more accessible to students (Gwekwerere, 2016; Ugwu & Diovu, 2016). Gwekwerere further stressed that integrating indigenous knowledge in science classrooms makes the lesson more practical and less abstract as students are actively developing an understanding of what they know already and how they perceive their environment. This paper also highlights aspects of indigenous knowledge suitable for chemistry instruction.

Akpan (2011) emphasized that traditional African science thrives more on the practical side, and their method is more of a technique than

a theory. This is why children are not taught all the principles of agriculture at home before going to the farm. Rather, they are exposed to farming, and based on their observation, the children raise questions. The elders also correct them during practice. Therefore, they gain both theoretical and practical knowledge concurrently. In the conventional chemistry classroom, a teacher will theoretically teach separating funnels before the learners are trained to use them. The indigenous knowledge system forbids such practice.

Furthermore, ethno-chemistry practices of different cultural groups may be explored as learning resources. Ethno-chemistry describes the chemical practices of identifiable cultural groups and may be regarded as the study of chemical ideas in any culture. Ethno-chemistry may help to sequence teaching/learning processes through previous knowledge of the culture to offer the opportunity for learners to know more about reality, culture, society, and themselves. By implication, the approach may encourage students to see and think chemistry within themselves and to arrive at meaningful learning and understanding towards proper application for improved achievement and retention. A critical look at the chemistry curriculum in Nigeria shows that very little is drawn from the reality of the learner's culture. For example, while teaching separation techniques, the curriculum draws examples from the Eurocentric standard separation technique to help learners develop integrated skills. It is convenient to argue whether there is any cultural practice close to the chromatography of the West. It is important to note that the extraction of dyes predates the arrival of Western Chemistry.

In addition, Omilani (2019) asserted that some African oral literature (proverbs and Incantatory poetry) may be used as an analogy in science classrooms. Inherent in most of these oral forms is evidence showing that the traditional African man is a compendium of knowledge and master of his natural environment (Ogunjimi & Na' Allah, 2005). The thought pattern that provoked most of these oral forms reflects the African men's high level of perception and reasoning. For example, when they say 'Orí kìíkún,ká pa ejò níbẹ̀,iná ni' (A bushy hair cannot have snakes crawling in it but lice). This proverb is an outcome of reasoning that focuses on the concept of habitat and adaptation features of animals. When they also say 'ajá tórelé ẹkùnyóò fi ẹ̀jẹ̀wẹ́' (a dog who visits the tiger will be bathed in blood) or 'Ògìdánò ní wà lódò kí ajá débẹ̀lọmumi' (When the lion is at the river to drink, the dog does not come to drink). These two oral forms indicate that the traditional African man understood the concept of predation. In chemistry, the teacher deploys analogy to explain the concepts related to the symbolic and submicroscopic levels. For example, electron-rich are used to explain electrophiles, proton-rich is used to explain nucleophiles, and salt bridge describes a weak electrolyte connecting the oxidation and reduction half cells in an electrochemical cell. The words "rich" and "bridge" are simply analogies so learners can transfer their understanding of everyday life into the chemical world. African proverbs can be used as an analogy for teaching many concepts in chemistry. For example, 'afọwọ́ fọnná kìí dúró rojọ́' (he that is holding fire with his bare hands is always in a hurry) can be used as an analogy when explaining the concept of entropy or the relationship between temperature and motion of molecules. 'Ilélàá wò ká tó sọmọ lórúkọ' (A name is given after consideration is given to the child's family) can be deployed as an analogy while teaching naming of organic compounds.

Besides the chemistry classroom, indigenous knowledge can be integrated during the pre-service science/chemistry teachers' preparation. Their preparation usually takes place in three major areas. The content preparation takes place in the cognate department (Faculty of Science), pedagogical preparation is done in the other department in the Faculty of Education, and pedagogical content preparation is done in the Department of Science and Technology Education. The pedagogical content preparation in chemistry and most other science subjects exposes the pre-service teachers to the knowledge of selecting instructional materials for the content, selecting an instructional strategy, knowledge of students' misconceptions, and the learning theories that are the basis of curriculum and teaching in their subject areas. Indigenous knowledge of science education understood many principles utilized during the pedagogical preparation. For example, the elders say 'bíọmọdé ò bá mọ owe lówe, tí kò mọòwèlówè, amú owe sọtùn-ún, amúòwèsósì, láti fi hànán' (Owe and Owe are two species of legumes that are similar and an attempt to make a child make a distinction between the two; must be done with the use the legumes as instructional material).

Also, while teaching the theories of learning, within the indigenous system's thinking, many things are like postulates of the theories of learning in science. For example, The Vygoktsky social constructive theory of learning emphasizes the diagnosis of the learners' zone of proximal development. The theory also asserts that learning takes place during social interaction. In the African indigenous system, among the Yoruba people, there is a proverb that says, 'Ọwọ́ ọmọdé kò tó pẹpẹ, tí àgbàlagbà kò wọkèrègbè' (The hand of the child cannot reach the height, but that of elders cannot enter gourd). Harnessing the theories in such a way that the teachers will have the indigenous perspective will help them to recall and adopt the theory when it comes to practice.

III. CONCLUSION

From the narrative provided in this paper, there is a parallel relationship between Western and African science epistemology. Given the similarities identified in this study, science/chemistry educators have many resources they can deploy to make the teaching and learning of chemistry meaningful. At the same time, chemistry instruction will accommodate their concrete and everyday experiences.

There is a need to develop a comprehensive and validated data bank that will include oral forms and ethno-chemistry practices relevant to teaching various topics in Chemistry. In teaching practical aspects of chemistry, there is a need to design lessons that can replicate many of the processes related to ethno-chemistry, such as soap making and extraction of dyes from leaves. Field trips should not be limited to locations with Western chemistry as its activity's foundation. Rather, visits to historical sites such as museums are good locations that should be considered adequately. In addition, African soap factories, blacksmiths, local breweries, and local dye factories are also good places for chemistry field trips. Also, resource persons from these identified locations can come to the chemistry classroom.

REFERENCES

Aikenhead, G. (2001). Integrating Western and Aboriginal Sciences: Cross-Cultural Science Teaching. *Research in Science Education*, 31, 337-355. https://doi.org/10.1023/A:1013151709605

Akpan, C. O. (2011). The method of African Science: A philosophical evaluation. *American Journal of Social and Management Sciences, 2*(1), 11-20. http://doi.org/10.5251/ajsms.2011.2.1.11.20

Amzat, J. (2019). Plucking the flower just too early: some community perspectives on age at marriage among adolescent girls in a Nigerian State. *The Nigerian Journal of Sociology and Anthropology, 17*(1), 1-16. https://doi.org/10.36108/NJSA/9102/71(0110)

Emeagwali, G., & Shizha, E. (2016). Interconnecting History African Indigenous Knowledge system and Science. In Emeagwali, G. & Shiza, E. (Eds*) African Indigenous Knowledge and the Sciences Journey into the Past and Present* (pp. 2-32). Rotherdam: Sense Publishers.

Gwekwerere, Y. (2016). Schooling and the African Child: Bridging African Epistemology and Eurocentric Physical Sciences. In G. Emeagwali, & E. Shiza (Eds) *African Indigenous Knowledge and the Sciences Journey into the past and present*. Rotherdam, Sense Publishers.

Jegede, O. J. (1995). Collateral learning and the eco-cultural paradigm in science and mathematics in Science and Mathematics in South Africa. Studies in Science Education 25, 97-137. https://doi.org/10.1080/03057269508560051

Jegede, O. J. (1997). School Science and the development of scientific culture. A review of contemporary science education in Africa. *International Journal of Science Education, 19*(1), 1-20 https://doi.org/10.1080/0950069970190101

Kaya, H. O. (2014). Revitalizing African indigenous ways of knowing and knowledge production. In M. Woons, & K. L. Belgium (Eds.), *Restoring Indigenous Self-Determination* (pp. 88-94). Bristol, UK: E-International Relations.

Ogunjimi, B., & Na' Allah, A. R. (2005). *Introduction to African Oral Literature and Performance*. Trenton and Asmara African World Press, Inc.

Omilani N. A. (2019). *Exploring the Prospect and Promise of African Proverbs in Science Education Being a paper presented at African Action Research Community Workshop at OFIRDI Centre*, Lagos State.

Omolewa, M. (2007). Traditional African Modes of Education Their Relevance in the Modern World. *International Review of Education*, 53, 593-612. https://doi.org/10.1007/s11159-007-9060-1

Richter, M. N. (1972). *Science as a Cultural Process*. Killington; Schenkman Book.

Schmidt, P. (1997). *Iron technology in East Africa*. Bloomington, IN: Indiana University Press.

Ssereo, F. (2012). Chemistry in Indigenous African Knowledge and Traditional Practices: Reflection on a personal experience. *African Journal of Chemistry Education, 2*(3), 7-15.

Taber K. S. (2017). Reflecting the Nature of Science in Science Education. In K. S. Taber, & B. Akpan (Eds), *Science Education: An International Course Comparison* (pp. 23-38), Rotterdam: Sense Publisher.

Ugwu, A. N., & Diovu, C. I. (2016). Integration of Indigenous Knowledge and Practices into chemistry teaching and students' academic achievement. *International Journal of Academic Research and Reflection, 4(4)*, 22-30. Retrieved from www.idpublications.org