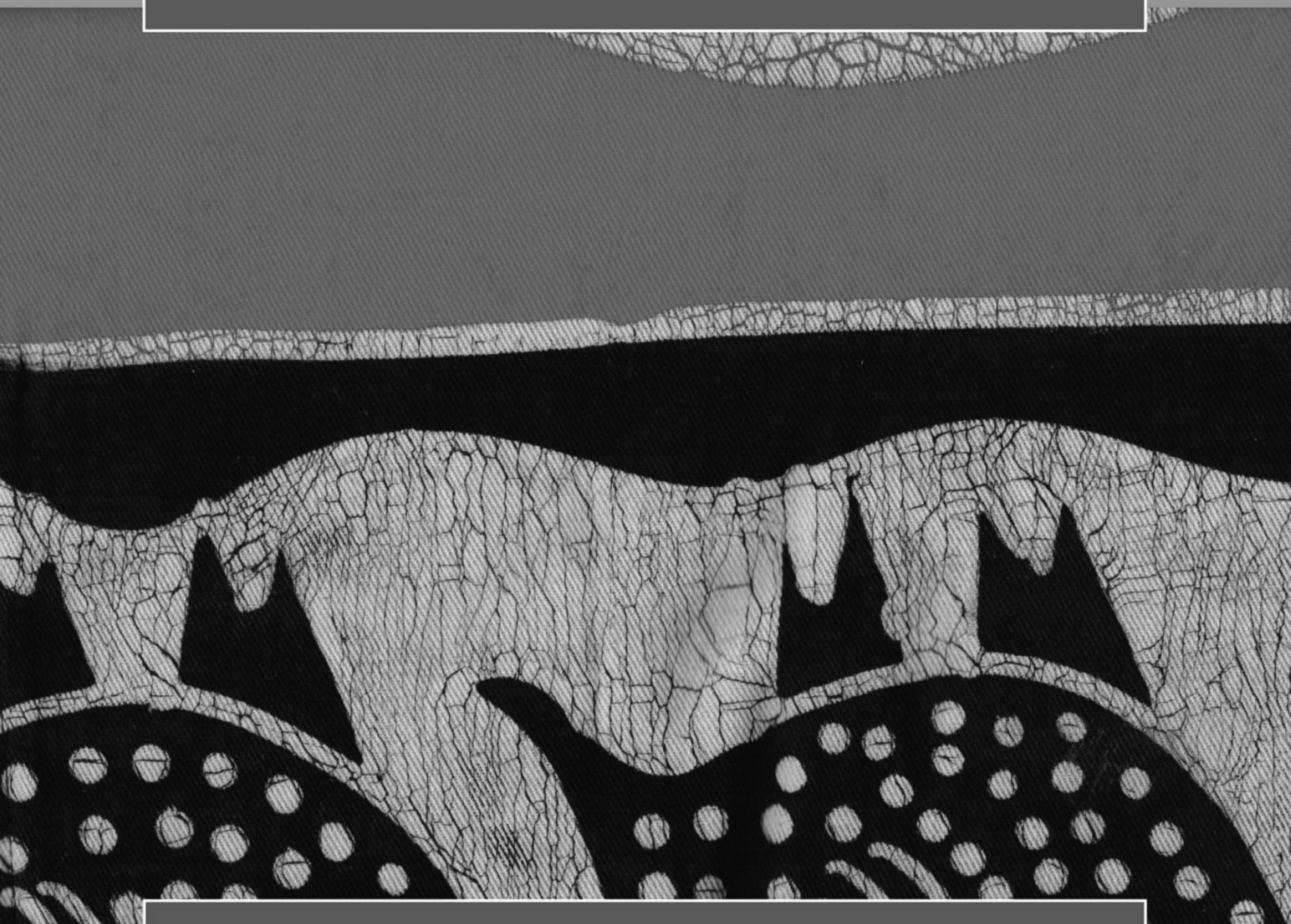
ANTI-COLONIAL EDUCATIONAL PERSPECTIVES FOR TRANSFORMATIVE CHANGE

African Indigenous Knowledge and the Sciences

Journeys into the Past and Present

Gloria Emeagwali and Edward Shizha (Eds.)



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African Indigenous Knowledge and the Sciences

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Volume 4

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Scope

Informed by an anti-colonial spirit of resistance to injustices, this book series examines the ways and the degree to which the legacy of colonialism continues to influence the content of school curriculum, shape teachers' teaching practices, and impact the outcome of the academic success of students, including students of color. Further, books published in this series illuminate the manner in which the legacy of colonialism remains one of the root causes of educational and socio-economic inequalities. This series also analyzes the ways and the extent to which such legacy has been responsible for many forms of classism that are race- and language-based. By so doing, this series illuminates the manner in which race intersects with class and language affecting the psychological, educational, cultural, and socio-economic conditions of historically and racially disenfranchised communities. All in all, this series highlights the ways and the degree to which the legacy of colonialism along with race-, language-, class- and gender-based discrimination continue to affect the existence of people, particularly people of color.

African Indigenous Knowledge and the Sciences

Journeys into the Past and Present

Edited by

Gloria Emeagwali
Central Connecticut State University, USA

and

Edward Shizha
Wilfrid Laurier University, Canada

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EDWARD SHIZHA AND GLORIA EMEAGWALI

INTRODUCTION

The aim of this text is not only to disseminate a historical background of African indigenous sciences, but also to dislocate and disrupt the notion that African indigenous knowledge is confined exclusively to the supernatural. What counts most is not simply discovering the origin of Africa's various forms of science, but unearthing the characteristics of what may rightly be called African science to compensate for centuries of marginalization and devaluation. The goal is also to understand the social and economic implications of impressive cultural innovations. Often, when discussing science in the context of Africa, an exclusively diffusionist hypothesis is projected in most literature with the tendency to perceive Africa as a passive recipient of foreign science without its own unique contributions. There is often a reluctance to consider or acknowledge that diffusionist hypotheses may well be irrelevant, questionable and false; paradoxically, most of the diffusionist theses proposed centuries ago by colonial anthropologists and pseudo historians, have never been in any way confirmed. Furthermore, there is, perhaps, cultural or political resistance to accepting the evidence that Africa has evolved its own explanatory framework and system of ideas as portrayed in the content and context of its indigenous knowledge systems.

Diffusionist theses have been fabricated to a wide range of fields, including iron production. The same can be said of several other endogenous achievements within Africa. However, within the last ten years much research on metallurgy and other technologies has been documented, in Africa and elsewhere in the world, and many diffusionist theories have crumbled under the weight of the evidence (Hughes, 2012). The publications that have emerged to rupture the diffusionism theory clearly attest to advanced indigenous expertise in African metallurgy and related technologies in general (Bocoum, 2004).

Explanations of worldly phenomena come and go, but acceptance of any explanation claiming to be "scientific" is constrained by the widespread belief that it should fit smoothly into the worldview prevailing in science at the time it is proposed (Callahan & Leeson, 2006, p. 2). However, the assumption of "a worldview prevailing in science at the time" is misleading as it connotes that there is one worldview that proffers scientific explanations. While we agree that science is not static, we disavow the notion that science has its explanations from a particular regional and eurocentric worldview. Definitions of any concept depend on the cultural worldview of the people who use the concept for their everyday practices. Any form of science is dependent on cultural practices (whether indigenous or western) and relies on direct observation, experience, experimentation, and interpretation.

Discounting and underrating scientific epistemologies and ontologies that are associated with indigenous societies has been a major tendency by Eurocentric observers. Building technologies, physics and mathematical principles used in constructing indigenous structures such as Great Zimbabwe are dismissed as non-scientific. In addition, ethno-medicinal treatment of illness and diseases as well as the application of spiritual healing from holistic geoscience and human interactions are viewed with suspicion. Rather than working within carefully constructed boundaries and methodologies established by cultural theories, they broadly generalize entire fields of academic expertise and dismiss many of them. Eurocentric scientism reduces science to a monolithic interpretation of the social reality using reductionist views, thus, restricting human inquiry.

African indigenous knowledge fulfills the expectations about science; although Africans do not consider themselves as "masters and possessors of nature," but respect nature as a resource that comes with sustainability considerations attached to it. Whether it is physics, geoscience or medicinal knowledge, African indigenous knowledge has existed for centuries and generations and has been sustainably utilized to serve African communities and societies. Indigenous knowledge has gained attention and acknowledgement as another form of science that can be used to explain phenomena and socio-cultural realities of diverse African societies. The authors in this book have taken the indigenous Africanist perspective to illustrate how indigenous knowledge reveals itself as a science. In the seventeen chapters that make up this text, authors point out, through historical narratives and illustrative data, that science in its different forms existed in African societies.

We shall now focus on some of the issues highlighted by the various contributing authors of this text, which is divided into five segments. In his discussion of pedagogical principles in technology teaching, Mishack Gumbo reminds us of the disservice to students from diverse cultural background of teaching strategies that fail to recognize the diversity of students. Place-based pedagogies synonymous with African indigenous ways of knowing and learning, which are relevant to the background, learning styles and student centered priorities of students, are necessary to make up for this pedagogical deficiency. His argument and point are endorsed by Yovita Gwekwerere who independently focuses on the Eurocentric bias of science education in Africa and seeks to narrow the gap between the teaching of physics, the curriculum and the experiences of children. Students should be given contextualized local examples with meaningful examples and illustrations from their cultural background, argues Gwekwerere, and she proceeds to give specific alternative models applying indigenous perspectives for achieving this end. Edward Shizha concludes the segment on epistemological and pedagogical issues with a focus on the diversity within Africa. He provides more examples of the appropriate technology that emerged from within Africa and expands on some of the issues discussed in this opening chapter.

Our intellectual journey then shifts to African perspectives on time through the scholarly discourse of Vongai Mpofu; Francis Muchenje, Ruth Gora and Ngoni Makuvaza; and Mathias Sithole, in three separate chapters. How do Africans perceive time? What distinguishes the rectilinear models of time from some of those that evolved within Africa? How do worldviews such as *Unhu*/*Ubuntu* intersect with African concepts of time? What about African management of periods of leisure and rest within a specific time frame? How do ideas about materials, circular motion, levers, centers of gravity, buoyancy, tension, friction, resonance, sound waves, energy and force manifest themselves in the African context. How best can we convey these principles to students of physics? These are some of the issues of concern to these authors. The segment on physics and cosmology concludes with discourses by Atah Pine on Tiv divination and Peter Alcock on South African indigenous knowledge about the stars.

We then move on to a slightly different area of discourse with a focus on West African enclosures and structures of various kinds by David A. Aremu, Aribidesi Usman and Patrick Darling in independent chapters. Gloria Emeagwali, looking at African traditional medicine, discusses some of the phytochemical reports that underlie many of the herbal resources frequently prescribed by medical practitioners. This segment on medicine and health is enriched by illuminating discussions on ethnomusicology and healing by Charles Aluede and Vincent Aiwuyo, and concludes with Evadne Ngazimbi's insightful chapter on indigenous narrative therapy. *African Indigenous Knowledge and the Sciences: Journeys into the Past and Present* concludes with a focus on metallurgy by two veteran archeologists, Jay Spaulding and Richard Darling who discuss ironmaking in East and West Africa, respectively.

We invite readers to embark on a stimulating intellectual journey with us as we illuminate the various dimensions of African indigenous knowledge systems and the sciences.

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PART 1

EPISTEMOLOGICAL AND PEDAGOGICAL ISSUES

GLORIA EMEAGWALI AND EDWARD SHIZHA

1. INTERCONNECTING HISTORY, AFRICAN INDIGENOUS KNOWLEDGE SYSTEMS AND SCIENCE

In this chapter we discuss the genesis of science in Africa with reference, first of all, to the South African Cape region, about one hundred thousand years ago (Jacobs, Duller, Henshilwood & Wintle, 2006). We then reflect on aspects of science as it evolved in ancient northeast Africa with some reference to ancient Nubia, Ethiopia and Egypt, highlighting aspects of the contributions made in ceramics, building technology, medicine and metallurgy. Brief references are also made to Southern Africa, in this case the Kingdom of Mapungubwe, precursor to Great Zimbabwe (Duffey, 2012). We reflect on some of the conceptual underpinnings of African Indigenous Knowledge (AIK) as science, and conclude with specific reference to the individual authors/chapters of this text and their contributions to this discourse on AIK and the sciences.

As pointed out in an earlier work (Emeagwali & Dei, 2014), evidence found at Wonderwerk Cave in 2012, in South Africa, point to the earliest use of fire-making in the world, going back a million years. Berna et al. (2012) discuss the dating of evidence from the site such as burnt bone and the ashes from plant remains. The scientific world also discovered, with amazement, that ancient Africans developed the capacity to mix paint in containers in the form of abalone shells, and coat their ornaments with iron oxide pigment as early as 100,000 years ago, thus creating a world record, yet to be superseded in the annals of ancient science and technology. Assumptions and conjectures were made and so, too, long-term projections, in the assemblage of hammer-stones, grindstones, ochre, animal fat, iron oxide powder, and charcoal, to make the paint in the mini containers. These discoveries of Henshilwood (2007) and Henshilwood et al. (2001, 2011) have not only cast new light on the African genesis of chemistry but they have also confirmed the fact that Africa was indeed a birthplace of science as we know it, and that indigenous knowledge capabilities to cope with the environment and create value have a long history in the continent. We also know that as early as one hundred thousand years ago, there were the beginnings of written symbolic language in the form of triangles and horizontal lines, also in ancient South Africa, based on the geometrical engravings that have been found. The discoveries of Blombos in the South African Cape, point to the earliest evolution of abstract design, creativity and symbolism in the world and marks some of the earliest documentation of African Indigenous Knowledge to date

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(Henshilwood et al., 2001; Tribolo et al., 2006). What is clear from these discoveries is that the knowledge evolving within the continent from this early period was aimed at problem solving, and involved specific trial and error experimentation and goals.

By 9000 BC, some of the earliest ceramics emerged in Nubia, predating those of ancient Egypt and Ethiopia, which may have lagged behind in this sphere, relatively speaking (Ehret, 2002), granted that Malian pots, dated 11,400 years ago, are older (Huysecom et al., 2009). By the Aksumite era of Ethiopian history, however, we have a wide range of ceramic products in the form of shallow thin-walled bowls, deep bowls with rims, basins, pots, jars, jugs, storage pots, braziers, legged vessels, beakers, semi-globular round-bottomed bowls, cooking pots, pedestal vessels and bird-shaped vessels, the product of indigenous innovation and skill (Phillipson, 2000, p. 303). Fast-forward to the early and late Aksumite era, between 1000 BCE and 1000 AD, and we have close to two hundred stelae obelisks, one of the largest being 33 metres (110 ft.) weighing 750 tons and representing a building, thirteen storeys high, the largest single block of stone ever quarried, sculptured and erected in the ancient world (Connah, 2001). Likewise, archeologists have found in this region, evidence of numerous multi-storied residences, elite houses and mansions, some of which may have been palaces. One of the present authors had the opportunity to view one of these elite structures dated about 1000 BC in Yeha, about two hundred kilometers from the town of Axum, where the former occupant of the building bitterly criticized the modus operandi of the German archeologists in charge of the excavation, complaining about the inadequate compensation given for the legacy of her ancestors that was reluctantly sold to the team conducting the excavation. The structure in question had more than twenty rooms and yielded pots dating back to about twenty seven hundred years. Other ancient structures in present day Aksum, Gondar and Lalibela include:

- Dams and Rainwater Cisterns
- Terraces
- Several subterranean multi-chambered tombs for the elite
- Complexes of courtyards and towers
- Stone castles, the nucleus of the court and capitals
- Stone altars
- Murals, many of which are in monasteries and ancient temples, painted with local pigment that seems to outlast synthetic paint.
- Sculptured churches and temples, sculpted between the 5th and 16th century in the highlands and Tigre Province. About forty-four temples at Gondar and a totality of more than 300 temples at Matara, Haoulti and Mantara. We may estimate about five hundred of these structures, bearing in mind that the discovery of ancient Ethiopian structures is an ongoing process.

We shall now make a few comments on ancient Egypt, whose mastery of medicine is celebrated in a variety of scrolls, named, unfortunately, after adventurers, merchants and others, rather than the ancient Egyptians themselves. In the so-called

Edwin Smith papyri, are careful discussions of injuries to the top of the head; injuries to the face; injuries to the jaw, neck, thorax, spine and arm; the names of human body parts and anatomy; neurological symptoms; the earliest known description of the brain; the first description of the meninges and brain pulsations; and a clear familiarity with the nervous system, blood circulation and the cardio-vascular system. But even so, Egyptian medicine was holistic and reflected a preoccupation with the supernatural, the divine and ancestral forces, in a manner that is quite familiar to scholars of African Indigenous Knowledge Systems. Invocations and prayers accompanied medication and were believed to be vital and indispensable for the medication to work effectively (Finch, 1998; Nunn, 1997; Sauneron, 2000).

Before the disruption of African technological advancement by slavery and colonialism, Africa witnessed the *in situ* genesis of an ironmaking industry that contributed to the technological heritage of humanity. The metallurgic know-how was a broad spectrum of expertise and included the making of steel in ancient Tanzania, as discussed in great detail by Schmidt (1997, p. 127):

> The Haya smelt had many distinctive features, including the preheating of the blast air, the efficient recovery of iron, the carbon boil, the formation of cast iron, and the formation of phosphorus rich cast iron. It is simply easier to believe that these many interlocking features arose from an incremental process of experimentation than to believe that they were learned as an ensemble by imitation. Moreover, reflecting on these innovations, one comes to realize that they are all, one way or another, adaptations to the chemistry peculiar to local materials: the limonite ores, the Mucwezi charcoal, the swamp reeds and the refractory tuyere clay.

Such technologies were also confirmed by Okafor (2004) in regard to the size and use of furnaces and the treatment and production of fuel, and de Maret (2004), who writes not only of technical diversity, but also of the importance of the cultural and symbolic diversity of African iron metallurgy. We should also note that in the case of ancient Nubia, in northeast Africa; Ghana, Mali and Songhay in West Africa; and Mapungubwe and Great Zimbabwe in Southern Africa, effective gold mining technologies emerged over time. Not only was ancient Nubia a major source of gold for Egypt, but it was also a major innovator and designer of jewelry. Markowitz and Doxey point out that "nothing exceeds Nubian jewelry and other items of personal adornment in terms of technical mastery, elegance of design, innovation and sheer beauty" (2014, p. 9). Nubian material artifacts speak a million words and are even more important than written documents, in our understanding of ancient technological wizardry. We stare in wonder at the delicately fashioned gold rosettes; hinged collars made of gold and silver; gold pectorals of Auset (Isis); the golden mask of Queen Malakaye of the Napata era; and numerous necklaces, ear studs, earrings, fly pendants, arm bands of gold and gilded beads. Some date as early as 2500 BC and the Nubian kingdom of Kerma. They reflect precision and detailed asymmetrical measurement, the product of standardized equipment and the weights and measures of precision found in excavations and "diamond shapes stamped from gold sheets" were applied to flat surfaces and wires hammered from thin pieces of gold (Markowitz & Doxey, 2004, p. 89).

As we shift to Southern Africa's Kingdom of Mapungubwe, variations of this technique appear in a wide range of exquisite gold objects, including the famous Golden Rhino, golden scepters, gold foil fragments with chevron patterns, gold beads and nails, necklaces, armlets, bangles and bracelets of all shapes and dimensions. As pointed out by Duffey, Tiley-Nel, de Kamper and Ernst (2008), many of Mapungubwe's objects are "rare and unique in the world" (p. 26), yet they continue to be Southern Africa's best well-kept secret, totally ignored in numerous textbooks, and relatively unknown by the very descendants of these sophisticated metallurgists. Unfortunately, post-apartheid South African authorities continue to keep some of their most cherished historical artifacts within remote game parks, inaccessible to many of its citizens and frequented mostly by head hunting tourists in search of animal trophies.

It is apparent that had the past indigenous sciences and technologies not been disrupted, they could have helped Africa to compete in the present technological advancement. In line with this argument, the dominance of western, Eurocentric scientism is challenged by Hutchinson (2011) who offers an insightful metaphor for the current controversies over science:

> The health of science is in fact jeopardized by scientism, not promoted by it. At the very least, scientism provokes a defensive, immunological, aggressive response from other intellectual communities, in return for its own arrogance and intellectual bullyism. It taints science itself by association. (p. 143)

The bullish dominance of western science had a negative and destructive effect on the development of other technologies by undervaluing the creativity of other cultures and societies.

Scientific knowledge, in whatever form, definition and cultural context it may exist, is found in all societies. Each society has its own way of categorizing and labelling types of knowledge. However in African indigenous communities, knowledge is often treated as a holistic body of knowledge. African indigenous knowledge systems, which are based on the natural environment and human practices for human sustainable development, are intricately interrelated. As noted by Adyanga (2014), these science practices are generational and synergistic with other disciplines such as history, geography, trade and commerce. African indigenous science is embedded within the larger body of knowledge constructs that constitute African indigenous knowledge systems. While most research and publications have focused on social science theories and paradigms (Emeagwali & Dei, 2014), less has been written with regards to the so-called 'natural sciences'. This book seeks to fill the gap and address some of the misconceptions about the African indigenous knowledge. Of particular interest in this book is how physics, geoscience and other sciences were developed and utilized in African societies.

African civilization and societies are replete with cultural knowledge that is deeply rooted in local cultures and everyday lived experiences. African indigenous societies have, for centuries, developed their own sets of lived experiences and explanations relating to the environments they live in (Kimwaga, 2010). Our argument in this book is that indigenous sciences have always existed in African societies. This is due to the fact that the way knowledge is produced and utilized and how people actually learn it and transmit it is culturally specific. Different cultures have different ways of experiencing social reality and, hence, different ways of categorizing knowledge (Shizha, 2015). This is influenced by their worldview and belief systems as well as perceptions about the natural environment, including the socio-economic and ecological context of their livelihoods (Shizha, 2014). In fact, the history of Africa's indigenous ways of knowing and knowledge production did not begin with the coming of Western knowledge systems, and neither should their future depend exclusively on Western and other worldviews (Kaya, 2014). Unfortunately, rather than western science acknowledging the multiple, collaborative and accumulative dimensions of knowledge, western scholars and scientists attempted to either dismiss, devalue or negate indigenous knowledge as being not worthy of scholarly engagement (Emeagwali & Dei, 2014; Shizha, 2015). In the same vein, there are also African scholars who have been 'miseducated' in western paradigms and perspectives of what is perceived as scientific knowledge who tend to mythicize and devalue indigenous science. Many African scholars went through a western education system that indoctrinated them to view African indigenous knowledge and its scientific epistemologies and ontologies as irrelevant to 'modernization', and hence invalidated and irrelevant. However, as various authors reveal in this book, African scientific knowledge has a role to play in human development as it is widely practised in African communities and used to solve problems that affect communities and their members as they encounter challenges from their ecosystems and cosmic environment.

While science, from a western, theoretical and methodological perspective, is judged from a positivist approach, indigenous science is defined from its holistic and utility perspective. Indigenous science is better understood as practical, personal and contextual units which cannot be detached from an individual, their community or the environment (both physical and spiritual). African knowledge, and its method of acquisition, has a practical, collective and social or interpersonal slant (Owusu-Ansah, 2013). Before the advent of Western methods of scientific inquiry, African knowledge and methods had successfully guided people in all spheres of life, including the spiritual, social, educational, agricultural, political and economic (Tanyanyiwa & Chikwanha, 2011). Knowledge of science empowers members of society with the abilities and capabilities to deploy and employ practical techniques and skills to manage their natural environment and to find ways to solve human problems. This is the central theme is this book. Different authors have examined different ways in which African indigenous sciences were utilized by African people to advance knowledge and to develop skills and abilities to make sense of their natural world and to improve their livelihoods. Indigenous African science encompasses a sophisticated array of information, understanding and interpretation that guides interactions with the natural milieu: in agriculture and animal husbandry, hunting, fishing, natural resource management, conflict transformation, health, the naming and explanation of natural phenomena, and strategies to cope with fluctuating environments (Semali & Kincheloe, 1999; Kante, 2004; Horsthemke, 2004).

Indigenous knowledge systems constitute the core of community-development processes in agriculture, the preservation of food, collection and storage of water, animal husbandry and ethnic veterinary medicine. It also forms the basis of indigenous interpretation of meteorological and climatic phenomena, orientation and navigation on land and sea, as well as in the management of natural resources. Indigenous knowledge is also very useful in local primary health care, preventive medicine and psychosocial care as well as the role of procreation (Abah, Mashebe, & Denuga, 2015). Indigenous people possess an immense knowledge of their environments, based on centuries of living close to nature. By living in and from complex ecosystems, they have an understanding of the properties of plants and animals, the functioning of ecosystems and the techniques for using and managing them, a system that is particular and often detailed and transmitted to the younger generation through traditional songs, stories, narratives, epics, legends, dreams and practices (Abah et al., 2015; Chikaire et al., 2012).

Technical knowledge or science is always adaptable and malleable. It is knowledge that evolves and adapts to the changing circumstances in which members of the communities find themselves. In fact, indigenous knowledge has not remained static, neither has it been confined to the shores of the African continent. Like all knowledge systems, such knowledges have diffused and interacted with other ways of knowing from other communities (Emeagwali & Dei, 2014). Its adaptability enables local African communities to better understand the differences and interactions between their science and other knowledge systems in order to reconstruct their own knowledge systems and to make better-informed decisions about which knowledge (internal or external) is appropriate for their sustainable future (Seleti, 2010). It is heartwarming that development practitioners are starting to realize the importance of recognizing and working with indigenous knowledge sciences, which builds on generations of experience, to best support the adaptive capacity and strategies of rural communities. There is increasing acknowledgement that indigenous forecasting methods are locally relevant and needs-driven, focus on the locality and timing of rains, and are communicated in local languages and by local experts known and trusted by the people themselves (Kaya, 2014; Chikaire et al., 2012).

Science and its methods of investigation and ways of interpreting social and natural realities cannot be divorced from a people's history, cultural context and worldview. Worldview shapes consciousness and forms the theoretical framework within which knowledge is sought, critiqued and or understood (Sarpong, 2002 cited in Owusu-Ansah & Mji, 2013). Almost all knowledge has cultural relevance and must be examined for its particular focus without universalizing it in the manner that western scientific thought and methodologies seek to do. According to Asante (1987, p. 168), the hallowed concepts and methods within western thought are inadequate to explain all of the ways of knowing because “universality can only be dreamed about when we have ‘slept’ on truth based on specific cultural experiences.” While we should be careful not to universalize western science as *the* relevant and valid knowledge, we should also be careful not to universalize African indigenous science as homogenous and universal to all African societies. Indigenous African science is unique to each African society, although there may be commonalities within these bodies of knowledge. We should acknowledge that even in African societies themselves, there are different forms of scientific knowledge since each society may have its own way of viewing social reality, and its own way of interacting with the natural world. African indigenous science is place-oriented and often orally transmitted partly because it is people-centered. Indigenous science is primarily concerned with the utility, accessibility and practicability of knowledge.

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MISHACK T. GUMBO

2. PEDAGOGICAL PRINCIPLES IN TECHNOLOGY EDUCATION

An Indigenous Perspective

INTRODUCTION

In this chapter, the author proposes principles that should be considered when teaching technology in indigenous contexts. The chapter is not about educational technology, computer integrated teaching or information and communication technology. The chapter is about *Technology Education,* which is a school subject taught to students. Around the world, many teachers teach in indigenous or multicultural contexts, yet they are poorly prepared to do so. They simply turn a blind eye to integrating pedagogical perspectives that recognize indigenous learners during their teaching. Passive learning seems to be a predominant outcome (Lavonen, Autio & Meisalo, 2004) because students are turned off by the pedagogical strategies that do not consider students' diverse cultures. This problem is compounded by curricula devoid of content from indigenous places, as well as teaching and learning materials that neglect such content. There is a great need to utilize the wealth of local indigenous knowledge systems and to incorporate them into mainstream formal education (Msila, 2007).

Literature abounds with accounts of the marginalization of indigenous learners or diasporans when it comes to the teaching of technology (Apple, 1986; Eggleston, 1996; Zuga, 1997; O'Riley, 2001). The universalist and industrial approaches (Fleer, 2015) monopolize the content and pedagogy of technology education. But inclusive pedagogy concerning indigenous students is an under-researched phenomenon. In this chapter are suggested principles that could transform the teaching of technology to the benefit of indigenous students. These principles are sourced from the literature and they are anchored on collectiveness, holism, co-creative orientation, cooperative approach to problem solving, experiential knowledge, orality, ubuntu, spirituality, values and complexity (Gumbo, 2014; Ngara, 2007; Masango, 2006; Emeagwali, 2003), these principles relate very closely to the life principles of indigenous communities.

In order to arrive at these principles, there is a need to define technology and technology education, curriculum and pedagogy, and argue that technology teaching needs to change, as well as to briefly discuss frameworks that support the suggested principles. The approach in the chapter is explorative and is not focused on one country only.

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DEFINITIONS OF TECHNOLOGY AND TECHNOLOGY EDUCATION

Technology

Technology is about engaging complex processes that involve knowledge, skills and resources available in various environmental contexts, to produce solutions to societal problems or to meet needs and/or wants. The Department of National Education in South Africa, now the Department of Basic Education (DBE), defines Technology as, “the use of knowledge, skills, values and resources to meet people’s needs and wants by developing practical solutions to problems, taking social and environmental factors into consideration” (2011, p. 8). According to *Indiana Technology Education Curriculum Standards* (2006, p. 3),

> Technology is a body of knowledge and action, used by people, to apply resources in developing, producing, using and assessing products, structures and systems in order to control and modify the natural and human-made (modified) environment.

Through the help of other scholars, Williams (1996) defines technology through its characteristics. According to Williams (1996, p. 3), therefore, technology:

- extends human potential through action;
- addresses human needs and wants;
- is a human creation and is thus implemented and used by people;
- is mostly and practically implemented through the use of tools, machines, techniques, systems and technical ways;
- exists in, affects and is affected by society and culture;
- is evident in every culture irrespective of its level of sophistication or stage of development;
- enables people to exert control over the natural environment;
- is important for the people to survive; and
- is future orientated.

Since this chapter is written from an indigenous knowledge systems angle, it is important to consult literature about the indigenous definitions of technology. According to Senabayake (2006), indigenous knowledge is unique and closely related to a particular culture or society and can thus be referred to as local/traditional knowledge, folk knowledge, people’s knowledge, traditional wisdom or traditional science. The fact that indigenous knowledge is mostly evident in practical activities such as agriculture, food preparation and conservation, health care and education (Senanayake, 2006), qualifies it to be referred to as indigenous technology (Battiste, 2002; Robyn, 2002; Kimbell, 2008).

Culture harbours both the material and non-material expressions of a people (Ogungbure, 2011). Alternatively, material and non-material expressions can be termed tangible or intangible devices, formulations and techniques which