



Abstract

Indigenous knowledge is any form of knowledge and/or practice that is an authentic expression or outcome of a people's history and intellectual evolution and experience. Innovation, on its own part, often occurs when an individual is equipped with in-depth and easily accessible knowledge of a particular field and/or locale. Indigenous knowledge is the most easily accessible knowledge for most Africans. It is also the variant of knowledge, which several Africans have in-depth knowledge of. However, indigenous knowledge has been left out of classrooms and other organized teaching, learning and research platforms in Africa, mainly due to the colonial foundations of education, and the contemporary realities of continued dependence on external actors for education funding. This paper attempts to weave a correlation between the low level of innovation experienced across Africa south of the Sahara, on the one hand, and the absence of indigenous knowledge in the education curriculum, and in research and development agenda, on the other. The study explores the concept of innovation and the experiences of certain nations, and establishes that indigenous or home-grown knowledge is foundational for innovation to thrive. The conclusion reached is that the recognition of indigenous knowledge in formal, informal and non-formal education and research in Africa is foundational for creating a generation of Africans who are innovators and inventors, and who are self-motivated to conduct research on issues affecting the continent.

Introduction

Innovation, invention and creativity are the major drivers of growth and advancement in nations across the globe. A country that invests in creating an enabling environment for its human capital to operate at optimum usually receives yields by way of highly innovative products and services. At the foundation of innovation and invention is knowledge, intimate knowledge of the environment within which the end –product will be utilized. Indigenous knowledge forms the basic foundation of knowledge for much of Africa's population south of the Sahara. Conversely, rather than ideally forming the foundations for teaching and research across the region, this variant of knowledge has been marginalized from formal learning and research platforms. This state of affairs is traceable to the colonial origins of formal education and research in Africa, and the continued dependence on external forces for education funding (Brock-Utne, 2000). He who pays the piper dictates the tune; rather than an emphasis placed on Africa's indigenous knowledge in curriculum and in research focus areas, western curriculum and western agenda usually form the basics. This paper seeks to explore the correlation between the low level of innovation and inventions in Africa and the absence of indigenous knowledge in teaching, learning and research across the continent. It starts by exploring the fundamental tenets of innovation and moves on to attempt a definition and conceptual clarification of indigenous knowledge, before looking at a correlation between the





two, by drawing examples from regions outside of Africa. The conclusion is anchored on the assertion that an emphasis on indigenous knowledge is crucial in Africa's drive towards overall advancement and economic growth.

Innovation

Innovation generally entails the idea of doing new things. It is the whole process of renewing, changing, transforming or indeed creating more efficient and effective means, products, processes or ways of doing things. There is widespread convergence around the fact that innovation is a major source of organizational or national wealth (West, 2000; Drucker, 1992). It has been said that innovation rules the world; nations that are constantly innovative have been shown to grow at a much higher rate than nations that are rich in mineral, human or any other resources (OECD, 2000). A good example is the United States, where it was assumed for over 200 years that economic growth came about as a result of input of capital and labor in the production process in order to result in a greater output. However, Robert Solow, who would later win a Nobel Prize in Economics for his work, was one of few economists who discovered that only 15% of economic growth in the United States between 1870 and 1950 occurred as a result of increased input of labour and capital (Rosenberg, 2004). That is, between 1870 and 1950, increased input of capital and labor "could only account for about 15% of the actual growth in the output of the economy. In a statistical sense, then, there was an unexplained residual of no less than 85%" (Rosenberg, 2004). It was the unexplained residual of 85% that "persuaded most economists that technological innovation must have been a major force in the growth of output in highly industrialized economies" (Rosenberg, 2004).

Today, innovation in science and technology remain a major force in determining the rate of economic growth recorded by nations. Nesta, the United Kingdom's innovation foundation, conducted a study, which established that between 2000–2008, 63% of the growth rate recorded in the United Kingdom could be attributed to innovation, while only about 37% could be linked to more inputs of capital and labor (Nesta Foundation, 2013). According to the Foundation, "the Research, ability to turn ideas into useful new products, services and ways of doing things is the wellspring of prosperity for any developed country" (Rosenberg, 2004). Source - (Nesta Foundation, 2013)

Technological innovation is at the bedrock of the quest for improved economic growth in most nations across the globe. Innovation in several developed economies is a result of intentional, consistent and sustained investments in industrial and technological research by governments and private sector (Grossman, 1993). Technology implies the application of scientific knowledge, and often entails invention, innovation or the creation of a new product or method (Gordon & Waage, 2010).





If investment in appropriate technology is key to innovation, it is important to understand the concept of appropriate technology. For technology to be considered appropriate it must be founded on certain fundamental principles, which include:

- Accessibility and affordability
- Ease of utilization and maintenance
- Meeting real needs of end users
- Effectiveness

Innovation in the fields of technology, therefore, should have the aforementioned attributes in mind. The implication is that there is the need for a deep knowledge of the environment where the product being developed is to be utilized. Researchers, inventors and innovators who have an intimate understanding of their environment are often the ones who succeed in developing needful technology or other products, tangible and intangible, which impact the environment in deep and meaningful ways, oftentimes bringing about transformation and noticeable progress.

In a groundbreaking theory, Basu & Weil (1998) proposed that localized innovation is a strong and driving force in economic growth. According to the theory, new knowledge, although relevant for increased technological production can only be applicable or appropriate when used in those “countries that produce according to technologies similar to the innovator’s technology” (Los & Timmer, 2003). The implication is that when a product is developed in a particular environment, the innovation needed to improve on that product or develop offshoots from that product is more likely to be generated from the same environment where the original product was created. In essence, the idea of transferring technology is not sustainable since it is highly unlikely that imported technology will easily take root in a foreign environment and form a basis for more innovation in its new territory. It is in this regard that appropriate technology needs to be situated in the pre-existing technological knowledge or environmental reality of the innovator. This is where indigenous knowledge comes to the fore.

Indigenous Knowledge

Indigenous knowledge is the local knowledge that has been distinctly generated from a particular society over a time period. As distinct from the globally acknowledged knowledge that is often the products of research institutions, institutions of higher learning and privately owned firms, indigenous knowledge is “the unique, traditional, local knowledge existing within and developed around specific conditions of women and men indigenous to a particular geographic area” (Warren, 1991). Indigenous knowledge is specific to a particular region, while modern knowledge is usually seen as being universal in nature.



Stilltoe (2002) would define indigenous knowledge as:

Culturally informed understanding inculcated into individuals from birth onwards, structuring how they interface with their environments. It is also informed continually by outside intelligence. Its distribution is fragmentary. Although widely shared locally on the whole than specialized knowledge, no one person, authority or social group knows it all... It exists nowhere in totality, there is no grand repository (9).

Indigenous knowledge meets all the definition of what appropriate technology entails, which as earlier spelt out, are; accessibility and affordability; ease of utilization and maintenance; meeting real needs of end users and effectiveness. Indigenous knowledge is accessible by members of the community at little or no costs. It is very easy to use and maintain. That is, there are often times, little or no need for the importation of spare parts or expertise for indigenous knowledge to thrive and flourish. Indigenous knowledge, being the kind of knowledge that evolves in response to environmental challenges has been established as being effective in meeting the needs of end users. In recognition of the importance and potentials of indigenous knowledge in bringing about advancement within communities, the World Bank asserts that,

Significant contributions to global knowledge have originated from indigenous people, for instance in medicine and veterinary medicine with their intimate understanding of their environments. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generation to generation and closely interwoven with people's cultural values. 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 lives (World Bank, 2013).

During a presentation made in 2005 at the World Bank organized international workshop on indigenous knowledge in Benoni, South Africa, Marthinus Horak noted that "Indigenous knowledge system (IKS) is different, but equal to 'Western' knowledge systems. IKS may have ancient origins, but is relevant in day-to-day lives of people and continues to evolve, and is highly validated in context of community/local use (Horak, 2005). It is important to emphasize Horak's point that indigenous knowledge is evolutionary and given to improvements. This is because indigenous knowledge is often viewed as traditional in nature, that is, static, immovable, and resistant to modifications, expansions and transformations in tune with the times. Indigenous knowledge, to continue in relevance, must be able to adapt to changing conditions and environmental realities in the location where it is established.

Indigenous knowledge and Innovation

Innovation is often a product of in-depth knowledge and expertise in a particular field. People who are well versed in indigenous knowledge and who also understand their environment intimately are more disposed to being inventors and being innovative, if the right kind of





support and access to information are made available. However, technology transfer or extension of technologies from developed, industrialized countries still thrives, in the form of “new crop varieties, medicine, fertilizers, computer hardware and applications and agricultural machines.” Although technology transfer has assisted Africa in some way, it has, however, consistently proven to not be what can launch the continent into the level of advancement it needs. Indigenous people are often lacking in appropriate knowledge regarding the maintenance of imported technology and techniques. Africans, therefore, remain dependent on the importers to upgrade the latest technology, making importation of technology unable to make any meaningful contribution to the GDP of sub-Saharan Africa. On the other hand, indigenous technologies or knowledge have been developed and utilized over an extended period in Africa. It has been tried and tested within local communities and have proven to meet the immediate needs of the people. Examples include natural medicine, agricultural techniques, governance mechanisms etc. As a matter of fact, indigenous knowledge is known to have laid the foundation for quite a few of what is considered modern knowledge or technology. In the United Kingdom, the efforts of Evan Thomas, a traditional bonesetter of enormous talent and training, based in Liverpool whose satisfied clients included Prime Minister William Gladstone, transformed the field of traditional bonesetting to modern orthopaedic medicine (Green, 1999).

In China, the establishment of university level education in orthopaedic medicine, at the initial stages, copied the curriculum available from Western universities. But it was not long before Chinese trained orthopaedic medical practitioners opened up to indigenous knowledge of Chinese traditional bonesetters. These westernized trained medical doctors have been able to redesign and severally re-modify given assumptions inherited from the west, through their interaction with the knowledge of Chinese traditional bonesetters (Shang & Dong, 1987). An example is the traditional bonesetter’s superior treatment of displaced bone fractures of both forearm. The western method of dual plating was displaced by the bamboo split method used by China’s traditional bonesetters (Fang, Ku, & Shang, 1996).

In the case of much of Africa south of the Sahara, it should be noted that indigenous knowledge of health and healing was solely relied upon prior to the advent of the missionaries and the commencement of colonialism. The missionaries regrettably dismissed much of what is indigenously African as fetish, and demanded of converts to rely instead on medication imported from Europe. Africans, convinced that it is entirely founded on sorcery began to disregard indigenous medical practices and to rather patronize European medicine (Ahyi, 1997). However, several Africans still believe in the efficacy of herbal remedies and traditional healing practices such as bonesetting. But notwithstanding its high patronage, traditional medicine receives little attention in Africa’s educational system and research agenda. The institutional curricula, often founded entirely on western medical systems are closed and exclude research and development of indigenous knowledge practices and systems.





Africa's Indigenous Knowledge in Practice

Indigenous knowledge cuts across fields and sectors and the next part shall delve briefly into Africa's indigenous knowledge and its uses in select fields:

Indigenous Agriculture

Indigenous agricultural practices have been immensely beneficial in building food security across several communities around the globe. Odhiambo states that “Indigenous knowledge can reveal missing ecological keys which may help scientists develop alternative agricultural technologies less dependent on non-renewable resources (e.g., fossil energy) and environmentally damaging inputs (e.g. chemical pesticides) than conventional technologies” (1990, p. 3). In schools and research institutes in Canada, for instance, the years of experience of the aboriginal people in managing their environment and determining appropriate planting season and soil knowledge is a huge resource for researchers and policy makers.

There are several instances where indigenous knowledge in agriculture has resulted in increased output in the area of food production across sub-Africa. In Kenya, a colonial mandate of 1936 required every Kikuyu farmer to stop the practice of mixed cropping, which the colonialists considered as untidy. In its place, the European styled parallel-row mono-cropping was imposed. This adopted practice led to the Kikuyu farmer losing much in terms of yield, and also being exposed to immense production risks and severe environmental degradation (Warren, 1991, p. 3). About fifty years later, however, Warren (1991) notes that at the global and national levels, agricultural research centers have been able to scientifically prove the effectiveness and efficiency of the Kikuyu's indigenous mixed cropping systems. However, in the Kenyan education curriculum, the British imposed model is still being widely studied.

In Chad, local farmers had been using the indigenous zai rain-fed irrigation to successfully grow crops in the parched desert lands which they occupy. However, in a bid to modernize farming, the government of Chad borrowed heavily from the World Bank to finance modern irrigation agriculture in trying to achieve its food security goals. An initial attempt at commercial irrigation was unable to provide the necessary moisture to produce the needed tonnage of food. Farmers and communities became wary of submitting their lands for another project that might likely fail (World Bank, 1989). The farmers insisted that if given the opportunity, that a modified and upgraded zai method would be able to benefit the nation a lot more than attempts at commercial irrigation. The World Bank conducted a financial and economic rate of return analysis on the “cultivation of rice, wheat and sorghum, to determine the difference between the traditional rain-fed irrigation system and the more modern methods” (World Bank, 1989, p. 5). At the end of the analysis, it was revealed that in comparison, the upgraded indigenous irrigation method yielded more economic profitability, especially with regards to cereal cultivation, particularly wheat and sorghum, than the



commercially irrigated cereals. The World Bank would note in its recommendations, that “Governments and donors have tended to assume that farmers were interested in irrigated agriculture and failed to develop an understanding of how irrigation fits into the farmers’ economic strategy” (World Bank, 2013, p. 5). The World Bank would go on to advise that governments carefully consider the options available to them locally, before taking the decision to sink funds in commercial irrigation systems, “which are extremely costly in terms of both investment and operating costs” (World Bank, 1989, p. 28).

Regardless of the profundity of the study and its implications for transforming the face of farming in Africa and around the world, universities and research institutes in Chad are not known to be seriously involved in researching this unique indigenous irrigation method towards up-scaling “it to ensure increased agricultural productivity. On the contrary, the Chadian agriculture curriculum promotes government investment in commercial irrigation as a way to increase yield and combat food insecurity” (Ezeanya, 2011, p. 128). Other examples include the Neem bio-pesticides in Togo and Niger and (Warren 1991, 14) and ethno-veterinary Medicine and Fishing in the Niger River (Warren 1991, 14).

Indigenous Knowledge of the Environment

African communities have deep and intimate understanding of their environment, but this knowledge is not factored in when conducting research, environmental impact assessment of infrastructural projects or in designing policies that affect the environment. Indigenous knowledge of the environment implies thorough understanding of the life-cycle, development processes, location and other relevant details of the community terrain, including plant life, animal kingdom, and natural phenomena (Appiah-Opoku, 2005). Indigenous knowledge of the environment goes beyond its mastery to emphasize the fashioning of appropriate technologies for utilizing environmental resources in a sustainable manner” (Appiah-Opoku, 2005, p. 103). Among the Khoi-san people, a predominantly hunter-gatherer community found in parts of southern Africa, indigenous knowledge of the habitat is extensively used with high accuracy to determine the movement of animals and any change in weather conditions. Indigenous knowledge held in African communities are not generally known to western scientists and western knowledge systems, however, African students and researchers are taught with western curricula and are guided by western agenda and yardstick/background information (Knudston& Suzuki, 1992).

Indigenous knowledge is also much needed in the making of Environmental Impact Assessments (EIA) across African countries. The existing western based EIA models, have been criticized for being “technical, reactive and narrow in scope of application,” often rendering it inflexible and unable to accurately assess the impact of infrastructural projects on the environment (Appaih-Opoku 2005, 18). The western EIA models rely heavily on assumable and predictable socio-economic and political conditions, which are not usually applicable to much of Africa. Indigenous knowledge based EIA will be much more applicable



in understanding Africa's terrain as this has been beneficial in several projects conducted in the territory of the aboriginal Canadians, such as Beaufort Sea Hydrocarbon Production and Transportation, the Oldman River Dam, and the Norman Wells Oil Field Development and Pipeline projects (Berkes, 1988). African governments and researchers can borrow a leaf from the experiences of Canada in instituting indigenous knowledge based EIA procedures for Africa and insisting on this, especially with donor funded projects where western consultants are usually brought in to assess the impact of projects.

Indigenous Pharmacology

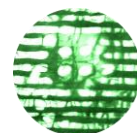
Indigenous pharmacology is a term that refers to the knowledge held by communities on the healing properties of plants, roots, barks, animal products, and other naturally occurring substances. Among African communities, knowledge of the healing properties of naturally occurring resources abound; diseases such as common cold, fever, sores, diabetes, malaria and fractured bone have been known to be remedied with knowledge passed on from generation to generation (Baronov, 2008).

Although western biomedicine has undoubtedly contributed enormously to the treatment and management of several diseases in the past century, in recent times, and with the exponential rise in diseases that defy diagnosis and remediation through western medicine, scientists are beginning to look into indigenous medicine. African countries hold great potentials for the discovery of herbs, seeds, animal sources, trees and even clay with healing properties. Some of the more recently established and scientifically proven African indigenous remedies that have been incorporated into western medicine, include; South African *Hoodia Gordini* for the treatment of obesity (Konadu, 2007); type II diabetes management drug from Kenya (McGown, 2006); *Aframomum stipulatum* proven to cure impotence from Congo Brazzaville (Berenson 2005); Iboga, (*Tabernanthe iboga*) is a plant used as stimulant for centuries in Central and West Africa and has now been established as an addiction cure (McGowan 2006), to mention few.

Indigenous Mathematics

African mathematics is a much overlooked field of study, but which holds enormous potentials for innovation across disciplines. Mathematics is an everyday field and is utilized by most adults at work, home and leisure, in varying degrees, and traditional African societies are not exemption. The teaching of Mathematics across Africa has continued in the European tradition established by the missionaries and consolidated during the colonial era. Apart from the much studied ancient Egyptian mathematics, mathematics of several communities in Africa south of the Sahara has received minimum attention from the academia.

Few African students know that some of the earliest mathematics objects in human history were discovered in Africa. The Lebombo Bone, dated approximately 35,000BC was discovered in the mountains of South Africa and Swaziland, while the Ishango bone dated



6,000 – 9,000 years was discovered in the borders of Uganda and Republic of Congo (Bangura, 2012). In African art such as textiles, wood carvings and mural decorations from diverse cultures and people groupings across the continent can be found consistent and in-depth geometrical expressions. Africa's numbering system also display a surprising similarity across several ethnicities and cultures, providing a strong platform for further research towards (Bangura, 2012).

Several indigenous African activities, games, end products and manufacturing processes are dense with lessons from mathematical sub-fields such fractals, combinatorics, bifurcation, tiling or tesellation (Bangura, 2012). In the sub-field of African Fractals, for instance, it is an American researcher Ron Eglash who has done the most work on the use of fractal patterns in African architecture, art and religion (Eglash, 2002). According to Eglash, it was in Africa that he encountered “some of the most complex fractal systems that exist in religious activities such as the sequence of symbols used in sand divination, a method fortune telling found in Senegal” (Eglash, 2002). In *African Mathematics*, Abdul Karim Bangura notes that although rarely studied, numerous African indigenous games involve combinatorics. African board games, for example, hold much promise for research as they are “games of strategy, full of information, logic and intelligence [and therefore] it is imperative to ask questions of intelligence, logic and mathematical reasoning when investigating them” (Bangura, 2012, p. 79).

Indigenous Knowledge and Research in Africa

There is an obvious disconnect between what is generally researched in Africa and what the real needs of the majority of Africans are. G.R. Woodman and B. Morse (1987) observed that it has proven difficult to design workable development strategies in Africa due to the fact that the region's contemporary approach to development is a complete deviation from the knowledge, principles and values of the indigenous communities over which the colonially contrived nation-states have imposed their rule. Education is the surest and quickest path to ensuring social continuity and bringing about transformation in any society. For Dewey, human beings “are born not only unaware of, but quite indifferent to, the aims and habits of the social group and have to be rendered cognizant of them and made to become actively interested; education and education alone, spans the gap” (Dewey, 1959, p. 3). Education ought to be based on the real-life experiences of learners and what their immediate environment and social realities entail. In this instance any “rift between curriculum and society must be bridged” (Walker & Jonas, 1986, p. 11).

The World Bank's admits that “educational research has shown that teaching supported with prior knowledge increases students' ability to grasp materials taught to them (...) and they are more apt to retain information.” (World Bank, 2000) The document further advises educators to utilize indigenous knowledge as the basis to “build on and teach new concepts” a process known as constructivist learning.” In sub-Saharan Africa, education and research has





mostly taken the form of an outside -in approach whereby the agenda of what is to be researched is set by the donors or development partners. This is also the case with curriculum of teaching and learning. Very few efforts, transformative in approach and content, has been put into modifying the curricula of teaching and learning across the continent of Africa, in order to make for independent, environmentally generated and sensitive teaching, learning and research.

Research that will lead to advancement in Africa will have to be founded on appropriate education. Classroom content must integrate “particular curriculum content and design, instructional strategies and techniques, and forms of evaluation” (Trifonas, 2003, p. 23). In Africa, research agenda, curriculum and “given” conceptual frameworks should be continuously re-examined by researchers, teachers and students, with the aim of eschewing all manifestations of neo-colonial underpinnings and emphasizing indigenous ideas and addressing Africa’s peculiar realities and challenges (Ezeanya, 2011).

In the search for knowledge within any particular community, people’s history, culture and worldview ought to form the baseline for further studies and analysis (Sarpong, 2002). Africa is rich with indigenous knowledge in all fields and sectors, which the advent of Western methods of scientific inquiry repudiated. The result of this disregard for what is authentically African in agriculture, science, mathematics, geography, arts, medicine, politics, economics, to mention few is a detachment of research from the people’s lived experiences. African researchers struggle for relevance and to have the masses appreciate their research output, but this has proven difficult over the years as a result of the disconnect that exists between research and reality. According to Mkabela, “it is the examination of the African reality from the perspective of the African; one that places the African experience at the core, recognises the African voice and reaffirms the centrality of cultural experience as the place to begin to create a dynamic multicultural approach to research” (Mkabela, 2005). It is very important, therefore, for African researchers to reacquaint themselves with Africa’s knowledge systems and research. There is need for African researchers to merge the Western acquired knowledge, skills, methodologies and tools of research with the African reality (Nsamenang, 1995). In essence, Western solutions and research strategies for discovering new knowledge are not made to measure for all. The West does not hold the key to research methodology and approaches for understanding the rest of the world. In Africa, the lack of emphasis on this truth has brought about distortions in efforts towards advancing the continent and its people. According to UNESCO, “new insights reveal that development interventions have failed to induce people to participate because of the absence of instruments and mechanisms that enable them to use their own knowledge. Greater efforts therefore should be undertaken to strengthen the capacity of local people to develop their own knowledge base and to develop methodologies to promote activities at the interface of scientific disciplines and indigenous knowledge” (UNESCO, 2000) African researchers are reluctant to tackle challenges facing the continent unless they are to be funded or to enter into some sort of partnership with





Western institutions. These are hindrances to authentic research works in Africa and the production of authentic knowledge out of the continent.

Conclusion

Despite decades of graduating university and post graduate students in Africa, there has been recorded a low level of innovation and invention across the region. The persistence of several developmental challenges and the snail speed drive towards technological advancement across Africa points to foundational issues with the region's research and development agenda. Africa, for instance, records the lowest patent application around the whole world and the question this begs is; how are the existing curriculum and research agenda contributing to the dearth of widespread innovation and inventions across the continent? Inventions, innovation and creativity spring from a place of familiarity and spontaneity. Indigenous knowledge is the knowledge that many Africans are acquainted with, but which is not incorporated in teaching curriculum and research agenda across the continent. Research for the average African researcher is an enigma that can only be unwrapped with funding, assistance or publication platforms offered outside of the continent's realities. Rich and potentially life- transforming indigenous knowledge in certain fields explored in this paper, such as agriculture, environment, pharmacology and mathematics if incorporated as part of curriculum of teaching, and a foundational part of research agenda in Africa, will most likely result in a remarkable increase in innovation and creativity across the region.

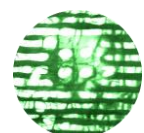
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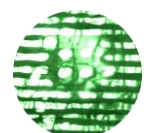


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