Social Forces Impeding Development of Science and Technology in Tanzania: The Case of Secondary School Science Education

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Abstract

This study examines the relationship between natural science knowledge and development of science and technology in Tanzania. It is a response to the puzzle that, why despite decades of dissemination of modern science knowledge, Tanzania is still technologically behind? The study uses qualitative methods of data generation and accumulation by disarticulation conceptual framework to analyze and explain this puzzle. Findings suggest that, imperialist forces in forms of colonialism, neocolonialism and neoliberalism have sporadically weakened the development of science and technology. In the neoliberal era, schools disseminate eurocentric, reified and disarticulated science that limits students' potentialities to invent and innovate relevant and articulated technologies. The study recommends on reconceptualization of natural science knowledge and dissemination of an articulated version.

***Keywords*:** *articulated knowledge, disarticulation, eurocentrism, natural science,*

Introduction

It is evident that science provides solutions to human predicaments and helps human beings to answer complex questions about nature. Further, scienceis an important channel of knowledge through which the world is explored and transformed (UNESCO, 2013). The application of scientific principles results in invention and innovation of sophisticated machines which eventually improve human lives. Worldwide, science and technology have improved human lives in many fields including industrial manufacturing, medicine, arts, transport, communication, administration and agriculture (Beda, 2019; Sampath, 2014). For these reasons, governments all over the world make efforts to produce and import and disseminate scientific and technological knowledge through various institutionalized mechanisms.

In Tanzania, modern scientific knowledge is disseminated through formal schooling, the process which started since colonialism. To date, the same knowledge is disseminated from secondary schools to universities. Despite these efforts of producing and importing scientific knowledge throughout all these decades, the nation is still technologically dependent (Edson, 2020; Gaillard, 2003). Tanzania is still importing modern technological devices ranging from gadgets to heavy machines. This happens amidst the long period of training scientists in the country. Why is this so? What's wrong with science education? What are the social forces impeding the development of science and technology in Tanzania? These are some of the questions this paper attempts to address.

Reasons for low level of science and technology in Africa

This part summarizes the main arguments raised by scholars who tried to study the problem of science and technology in Africa and Tanzania in particular. They are trying to respond to the question that, why is Africa/Tanzania still lagging behind despite decades of dissemination of modern science knowledge?

For Ogunseemi (2015), Africa is lagging behind in science and technology mainly because of the policy challenges. African governments have failed to make good policies that produce competent teachers. Low quality teachers and poor-quality assurance mechanisms contribute to poor performance in science and technology. However, Ogunseemi does not explain why the governments have not been able to produce good policies and teachers for all these decades. What are the social forces that limit production of competent teachers? In the context of learning, the study has attributed the problem of science and technology to just two factors, namely low quality teachers and poor quality assurance mechanisms while ignoring other important components like systems of knowledge production and dissemination. Similarly, there is no discussion on 'social values' held in the subjects' contents as reflected in school curriculum, syllabi and textbooks.

According to the UN (2003) study, technological challenges are among the main factors that hinder development in Africa. With evidence from Kenya, Tanzania, Ghana and Zimbabwe, the study discovered that, the skills base is very weak and the educational systems are generally not geared to meeting the skill needs of industrial competitiveness. Thus, at the end, the people become incapable of mastering both simple and sophisticated technologies. Despite this good observation, the study did not adequately explain what is wrong with the education systems to the extent that they do not promote the development of science and technology in Africa.

Focusing on institutional framework perspective, Oyeyinka (2017) is of the view that, low level of science and technology is a function of week institutions available

in Africa. Citing examples from the successful latecomers in industrial development such as the South East Asian countries, he highlights basic conditions like high quality technological institutions, high skilled engineers and professional managers. In most African countries, these initial conditions are missing, thus development of small and medium firms remain stagnant. The efforts of the governments to advance science and technology in Africa are basing on technology transfer particularly on machinery purchase and imitation of organisational forms of research and development rather than strengthening institutional capacity basing on conditions like education, inter-organisational collaboration, information and communication technology, and institutional support to SMEs.

Mjema (2013) views the problem of science and technology in Tanzania based on three main factors, namely low level of engineering education for both owners and workers in engineering firms, lack of linkage between engineering firms and research and development institution and unreliable market for locally produced products. According to him, majority of owners and workers in these firms have low level of engineering knowledge which at the end limits their capacities for innovation and invention. With this level of education, they cannot consult the available research and development institutions such as universities and Tanzania Industrial Research and Development Organization (TIRDO) for advancing their knowledge and skills, something which affects quality of their products. However, Mjema's findings are contradictory as in the same study (pg. 9) he claims that people with low engineering education are more successful than the highly educated ones. Thus, indirectly, suggesting that high level of engineering knowledge limits development of science and technology in Tanzania. The lingering question to be answered in this study is what are the social forces imbedded in science education that slow down the development of science and technology in Tanzania?

Arguing from a dependency perspective, Fabayo (1996) proclaims that, low level of science and technology in Africa is a result of relying on technology imports from western countries. The practice does not only impede science and technology, it also contributes to the underdevelopment of the African economy in general. In the process then, this distorts Africans' internal capability and efforts towards developing science and technology. Although this argument is valid, the study does not explain dependency in relation to science education. For instance, how has dependency affected schooling system in Africa and how have science subjects and actors affected the process?

Generally, assessing the arguments above, many studies have discussed the phenomenon descriptively focusing on empirical factors like policy framework, institutions incapacity and, illiteracy while ignoring social forces behind these

factors. The studies also have offered ahistorical accounts which do not take into consideration the historical evolution of science and technology in Africa. In this manner, Africa is portrayed as a continent without science, of which it is supposed to import scientific principles, machines and institutions from the West. Third, scholars who argue for improving the education system and natural science knowledge, discuss these variables as neutral, values embedded in science subjects/ institutions and are taken for granted. This study aims to fill this gap by revealing the social forces impeding the development of science and technology in Tanzania.

Conceptual framework

Accumulation by disarticulation is a conceptual framework which was developed by Amin (1974; 1976) and then advanced by Shivji in (2009). The framework dwelt on the Marxian theoretical orientation, which approaches society as a social formation. Under this framework, knowledge appears as a system of ideas stemming from material conditions of society. When knowledge conforms to these conditions it becomes articulated and liberative. On the contrary when knowledge does not conform to the conditions it becomes disarticulated and detrimental or repressive. Accumulation by disarticulation asserts that, the capitalist economy divides the world into two parts, namely centre and periphery. These parts are dialectically linked and from about 500 years ago there has been a transfer of wealth and resources from the periphery to the centre through primitive accumulation process. Although Marx saw this as just a phase in capitalist development, in the periphery, the process has remained unfinished. Consequently, the world economy is divided into two parts, viz. the core capitalist nations which function as manufactures and model of development and civilization and the peripheral nations which function as producers of raw materials and resources for the core nations. This international division of labour brings development at the centre and underdevelopment on the periphery (Amin, 1974; Teubal, 2001; Shivji, 2009; Sijuwade, 2011).

Thus, in light of accumulation by disarticulation conceptual framework, the periphery is disarticulated, wealth and resources endowed in the periphery are transferred to the centre (core) nations, leaving the periphery with poverty and backwardness. However, for this process to take place smoothly, disarticulated knowledge must be produced and disseminated. Just as manufactured goods, knowledge production also becomes a role of the core capitalist nations. The periphery, just receive this knowledge as given, authentic and developmental. Thus, because this knowledge is produced purposely for facilitating a smooth transfer of resources, it also becomes disarticulated as it does not conform to the conditions of the periphery countries. Using Freire's conception of education, knowledge in this context becomes a banking knowledge. It is the assumption of this study that, schooling disseminates

disarticulated natural science knowledge, which is disconnected from the social conditions of the society.

Methodology

This study used qualitative research approach in order to explain social forces that impede the development of science and technology in Tanzania. These forces are unobservable, hence cannot be captured adequately using quantitative means. Data were gathered through in-depth interviews, focus group discussions, observations and documentary review. The first three methods were used to gather information from teachers, parents and students while the later helped to gather historical information and other facts that could not be captured through oral conversation. The study employed purposive sampling procedures in which four secondary schools in Kinondoni municipality (two government schools and two private schools) were selected. In this study, Kinondoni municipality was not selected as a case with specific realities isolated from other areas of Tanzania, but as a reflective image and representative portion of all areas of Tanzania, since all regions are supposedly affected by the same social forces as well as knowledge production and dissemination systems. Also, selection of schools was based on the best performance in their form four National Examinations Council of Tanzania results. As such, students, teachers and parents participated in this study as consumers of knowledge, to share their experiences on knowledge production, dissemination and consumption. Analysis was done using thematic methods, whereas themes, subthemes and slices were sorted manually, and then interpreted using the accumulation by disarticulation conceptual framework.

Findings and Discussion

Development of natural science knowledge in Africa circa 1890s

It is a dominant perception for most of the elite Africans that natural science knowledge of which today is named as Physics, Chemistry, Biology and Mathematics is Western in origin. They also believe that Africa has no contribution to these supposedly foreign sciences. The following notions emerged from interviews and focus group discussions confirms this perception:

> For sure, they might be many sciences, but generally what we refer as science and what we teach in classes is not originated from Africa… there is no way, I have never seen any book about African scientists or even scientific laws from Africa. (IDI/Teacher/SS1)

However, the fact is far from these notions. Archeologists and historians reveal how the African continent was developed in natural science and technology

many years before the West. In terms of science and technology, Africans were highly developed than any other civilizations (Deming, 2010; Momoh, 2020; Peter, 2005). Science in African communities was acquired through two systems, namely family-based learning and community apprenticeship. In all these ways youth learned the principles and practices of science in maritime, architecture, engineering, mathematics, medicine, textile, Astronomy, navigation, metallurgy and tools (Peter, 2005; Van Sertima, 1998). All these signifies the development of science and technology in Africa long before the western knowledge and therefore science is not a foreign phenomenon in Africa as well explained by Waite (1987), Van Sertima (1998) and Colley (2017).

The development of medicine science in Africa for instance is explained by Diop (1987) and Momoh (2020) that, in the pre-colonial times, Africa had specialists in both pharmacology and epidemiology. There were medical specialists in eye, stomach, head surgery, toxicology, painkillers etc. Until 1879 African doctors were doing Caesarean surgery, a practice which was uncommon in Europe. Africans also discovered herbal plants such as *kaolin, rauwolfia* and *apocynaceae* which today are used in modern medicine (Cooley, 2017).

The same developments were observed in mathematics, engineering, textile, astronomy, navigation, metallurgy, tools making, architecture, public heath, writing technology, food preservation etc. (Momoh 2020). In Astronomy for instance Africans in Egypt charted the movement of the sun and constellations and cycles of the moon. They divided the year into 12 parts and developed a yearlong calendar system containing 365 ¼ days. They also made clocks with moving water. Another accurate calendar was developed in Kenya around 300 years BC, dominantly referred as African Stonehenge (Peter, 2005; Deming, 2010). In navigation evidence also show that Africans managed to create boats 5000 years BC and ships 3000 yeas BC; and they were the first to sail to America (Peter, 2005; Colley, 2017; Momoh, 2020). The construction of pyramids, city walls and great cities in Tanzania (Rhapta), Zimbabwe and Mozambique suggest a level of architectural and engineering knowledge of the Africans (Deming, 2010, Chami, Le Guennec-Coppens & Mery, 2002; Momoh, 2020).

The recent history (15th-19th Century) also reveals how Africans were developed in many aspects. Iaccarino (2003) and Tilley (2016) show scientific achievements in climate, soil, plants, veterinary, medicine, agriculture, food, conservation, fermentation, and many others. In the same line Mapunda (2002), shows the development of iron technology in East Africa. People of this area managed to make iron tools of different sorts. In some instances, they had better technology than European one. In this manner science and technology is not foreign to Africa.

It is part of African history and intellectual development. However, reading this section, one question remained unanswered, if Africa was developed this much where did these developments go? The following sections explain this in details.

Social forces impeding development of science and technology in Tanzania

The term social forces involve elements of society and social organizations that influence human actions. For Rummel (1976) social forces are the typical basic drivers or motives that influence a certain state of affairs. To use Selsam 'et al' (1975) words, these are not just causes or factors, rather, social forces denotes driving forces of the driving forces (empirical features regarded as causes/factors in idealist perspectives). In realist language these are the *underlying conditions* that shape social reality. By employing this definition, this section reveals a number of social forces that impeding development of science and technology in Tanzania. Using Lenin's conception of imperialism, the study argues colonialism, neocolonialism and neoliberalism have stagnated African traditional science and technology and at the same time have blocked the development of these elements. The following sections explain in details on how education systems under these three phases of imperialism have sporadically impeded the development of science and technology in Tanzania.

Colonialism and the suppression of science and technology

The debate about knowledge in Africa, whether on natural or social sciences, is dominantly reduced to colonialism. It is argued that, before colonialism, Africa was a dark continent, populated by uncivilized and ignorant people. Africans, they say, had no religion, no science no culture. And therefore, it was the burden of Europeans to civilized Africans. Drawing from this point of view, some scholars reduce the development of natural science knowledge to colonial period; that science and technology in Africa is a new thing, influenced by the colonial civilization mission. However, this is contrary to the arguments of Accumulation by disarticulation which this study is based. Evidence shows, imperialism of which colonialism is a part, did not bring science in Africa but destroyed the existed African science. As Explained above, manufacturing, medicine, astronomy, and other sciences had already existed in Africa for quite some time. Nonetheless, all these were destroyed by colonialism as they opposed the logic of colonial economy (Waite, 1987; Deming, 2010; Whitt, 2009; Ideland, 2018; Momoh, 2020).

Though colonialism imposed multiple conditions of destruction (trade, religion, laws) much of destructions were done through colonial *schooling*. According to *wa* Thiong (1986) this was the main agent of colonization of mind to Africans. In

social sciences for instance, African students were trained to acknowledge the role of the colonial government and to appreciate culture, religion and instructions of the colonial masters. The school syllabus for instance, insisted students to discuss colonial development projects and their advantages. Colonial government was seen as democratic, and the colonial repressive apparatus appeared as developmental.

In secondary schools, students were trained to take positions as teachers, clerks and other lower rank positions than understanding science and their social conditions. Majority of the Africans students did not train on science subjects (physics, mathematics, chemistry and biology) as it was not a priority. These sciences were introduced at the university level in late years of colonialism (Venkateswaran, 2007; Mukundu, Chenika & Madzudzo, 2017; Burton, 2020). In relation to natural science, colonial schooling introduced agriculture, carpentry, cookery, needlework, plowing, gardening, and hygiene (causes, treatment, and prevention of common illness e.g., Malaria, diarrhea etc.). Each school had a garden where students were supposed to learn characteristics of soil and vegetable growing. They also learned scientific names of plants and livestock. In all these, science was said to originate from the Europeans. This means students approached *science* as a foreign culture. They were supposed to discard all what they know about plants, medicine, agriculture etc. as they were *not scientific*. The underline assumption on this is that Africans had no science, they have to learn from the Europeans (Adesola, 2014).

The school context also reduced African students to empty containers. The teacher centered approach implied that, African students knew nothing and must internalize and memorize teachers' instructions. Given the colonial context where science was taught by the foreign teachers, using foreign books/language it reduced the whole content to European values. The question of learning then was reduced to the process of *banking education* whereas students learned how to appreciate Eurocentric ideas as scientific and genuine. Indigenous African science had no space in the colonial curriculum (Waite, 1987; Adesola, 2014; Colley, 2017).

Generally, what is seen in the whole period of colonialism, is the efforts of Europeans to refute African science for their benefits. African science was not recognized, not because it was inferior or uncivilized, but because it was against the interests of colonialism and the premises of modernization. Tilley (2016) for instance has recorded how African ecological and agricultural science was effective compared to European knowledge during colonialism. However, the colonists were skeptical of using the sciences; and the efforts of integrating African science in the *modern* paradigm did not materialize in the colonial schooling.

Neocolonialism and the state of science and technology

The above section has explained how African natural science was replaced by European model. This was not just a replacement, but in the context of imperialism it was a deliberate process of destruction. Natural science, just as social sciences, was molded to support the civilizing mission and the colonial project in general. At the eve of colonialism, formal education in general was Eurocentric in nature. In natural sciences, the 'noise discourse' was that connected science to the values and aspirations of Europeans, the colonial masters. Agriculture science, engineering, medicine etc. were more of "colonial sciences" (Tilley, 2016) rather than progressive natural science. Science subjects which by then were taught at the Makerere University did not escape this framework (Burton, 2020).

The neocolonial/postcolonial era (1960s-1970s) of which in Tanzania is mostly referred as the *ujamaa* era, covers a period of about two decades since 1961. After independence the government of Tanzania reformed many systems which seem colonial in nature. For example, in 1962 the government enacted The Education Act to eradicate all forms of discrimination in the education system. Pupils were enrolled regardless of their gender, religious or racial backgrounds (Mushi, 2009). In 1967 the government instituted Arusha declaration which introduced the concept of *Education for Self-Reliance*. This was to deconstruct colonial values inherited in the education system which for a great extent were pro-capitalist, emphasizing on white-collar jobs, individualism and private property rights. In light of the *ujamaa* philosophy, adult education was introduced to impart general knowledge including vocational skills. Later on, in 1974 the government introduced Musoma Resolution to make education more practical and more African.

Despite this progressive idea, the content and approach to natural science remained colonial in nature. This was influenced by the then context of which science curricula, textbooks and teachers were imported from Europe. Teaching and learning science programs in secondary schools was funded by the UK based foundation under *The Nuffield School Science Project*. Even science examinations were prepared by the University of Cambridge in Britain (Mhaiki, 1986; O-saki, 2005; 2007; Wandela, 2014). This context curbed the efforts of Africanising science in Tanzania.

The efforts of Africanizing knowledge were observed in all levels of education, at the university level, it was also insisted that, the university must produce scholars relevant to the conditions of the nation. In accordance with this view, the University of Dar es Salaam reformed her programs in both social and natural sciences. The latter was pushed by the need to implement large-scale infrastructural projects and industrialization (Burton, 2020). Thus, at the University, the government established Faculty of Engineering for the same reasons. Due to financial limitations, the

college was then funded by the West German government. The faculty received machines and technical staff from German. This contradicted the government ambition of teaching Africanized engineering, as the machines and staff were Western in origin, thus they used to disseminate Eurocentric engineering. Thus, to abide with *ujamaa* philosophy, the University of Dar es salaam introduced obligatory courses in development studies to students of all disciplines including engineering. This was said to produce Africanized engineers who will fit to the context of Tanzania and Africa in general (Burton, 2020). As a result, though technology and staff were western oriented, they tried to produce articulated products (such as farm implements and Gold ore leaching), a trial which did not live long due to neoliberal yokes.

Neoliberal forces, secondary school sciences and technological stagnation

After about two decades of neocolonialism, in 1980s Tanzania entered in the new era, the age of neoliberalism. This was the third phase of imperialism preceded by colonialism and neocolonialism. Neoliberalism as a social economic system preceded from the Washington consensus, whereby the world rich nations agreed to re-dominate the world through ideological reforms. The consensus then came up with Ten Commandments, which all aimed to weaken socialism, class struggle and social solidarity in the world (Shivji, 2009). On the contrary, the consensus promoted capitalist values such as the need to protect private property rights, free markets, and free trade. Neoliberalism then was adopted by World Bank and IMF as a theory of 'development'. These institutions, set loan conditions for developing nations; among other things the conditions forced poor nations to promote and protect private property rights, political pluralism/democracy, human rights, good governance, cost sharing policy, devaluation of currency, reducing government expenditure and other similar notions (Mamdani, 1994; Chachage, 2004; Harvey, 2005; Chang, 2007).

This transition affected the Tanzania social structure and the education system in particular. Few notable impacts include allowing privatization, inequalities, and Eurocentrism. This then accentuated the level of poverty, food insecurity, malnutrition, and other human predicaments. In academics, education for self-reliance referred to individuals and not for the nation. The *ujamaa* component of education was replaced by neoliberal philosophy. In arts subjects (such as civics and history), neoliberalism is so dominant. In civics for instance, the syllabus (URT, 2017b) and textbooks are all informed by neoliberalism and eurocentrism. Topics like Human Rights (form I), Democracy, Gender (form II), Economic and Social Development (form III), Culture and Globalization (form IV) are guided by the neoliberal philosophy which function as banking knowledge.

Human rights knowledge for instance, addresses various kinds of inequalities including gender, racial, age, except class inequalities. This conforms to neoliberal philosophy which embraces class division and individualization. Thus, students learn that, polarization has nothing to do with human rights, it is an acceptable social value to embrace. This is 'banking knowledge' as it aims to perpetuate oppression and exploitation rather than diminishing them. The same is also observed in the history subject; in form four for instance, topic 3 (*African States after Independence)* and topic four (*Africa in International Affairs)* reveals the dominance of neoliberalism and how the philosophy distorts historical knowledge of Africa (Matogwa and Sambaiga 2021).

Similar situation has also affected science subjects. As found in this study, secondary school students consume 'distorted' natural sciences that impede the development of science and technology in Tanzania. The reviewed syllabi and textbooks reveal, much of natural science knowledge in this level of education is 'banking knowledge' and 'disarticulated' from the students' social environments. Thus, at the end students fail to utilize the knowledge to understand, innovate and transform their environment. These distortions are systematically imposed and organized around the following pillars:

Europeanization of the natural science disciplines

The reviewed secondary school books present natural science as a foreign thing in Tanzania and in Africa. Everything in physics, chemistry, biology, and Mathematics is presented as it originated in Europe and Africa contributed nothing. For example, Physics is defined as a science originated from Greek which deals with the relationship between matter and energy. Even the term *Physics* is said to originate from the Greek term *Physikos* which means the study of nature. (URT 2010a:1). The same is observed in biology and chemistry. On biology, the authors note: *"The word 'Biology' comes from two Greek words; bios and logos. Bios means 'life' and logos means 'study'. Therefore, biology is the study of life" (URT, 2010b, p. 1).* A teacher clarified:

> These sciences are modern, they come from developed societies, so we make efforts to cope up with them. These European sciences particularly physics, chemistry, biology and the like, need efforts to understand them; they are uncommon in our context… in most cases contains modern concepts and principles. **(**IDI/Teacher/SS3)

Biology, comes from Greek, Physics comes from Greek, Mathematic and Chemistry the same. This Europeanization of sciences do not only end up on definitions, even

the scientific laws and formula represents this process. All scientific laws are coming from the European great scientists. Laws of motion were discovered by Isaac Newton; Laws of Floatation were discovered by Archimedes. The Triangle law, Parallegram law (vector). The laws of friction. Boyle's law, Charles' law (thermal expansion) were all discovered by great scientists from Europe (Jongo, 2018).

By considering these cases, it can be argued that, the field of natural science is *Eurocentric* and other continents (such as Africa) have contributed nothing in the whole body of science. This is what Depelchin (2004) calls the European discovering syndrome; one of the components in the grand project of imperialism. This kind of knowledge causes two main problems; first, when Tanzanian students learn that everything *scientific* started in Europe, they automatically tune their minds that they are weak & incapable of doing science, as science and technology appears external to them and a product of external society. For *wa* Thiong'o (1986) then, learning to these students becomes a 'cerebral activity' rather than an emotionally felt experience. The latter involves learning as culture, which reflects social struggles and self-determination. Dependency of this nature then internalizes inferiority complex to learners (Iaccarino, 2003; Ebaye, 2009). Second, it prepares students to perceive Europe and Europeans as problem solvers, innovators, exceptional and *special* race. This kind of glorification was reflected in focus group discussions with students. Below are some of the responses of the students when asked to explain the effects of colonialism in Tanzania and how colonialism relates to science and technology in Africa.

One response from FGD narrates:

> Yet, Europeans colonized us but paved the way for our development… but currently they are good for instance they have made smartphones for us… now you can read through your mobile phone…without them we would have been too backward. Even this education came from them… even the language we use is a European one… everything has positive and negative effects… (FGD/Students/SS2)

These accounts show how secondary school students perceive Europeans in relation to them (Tanzanians). For these students, Europeans are heroes despite their inhuman treatment of Africans during colonialism. These phases, *paved the way for our development… they have made smartphones for us… without them we would have been too backward… and without them we would have been underdeveloped than today,* tells much on how Europeans are glorified by these students. They perceive Europeans as great scientists, agents of development, innovators, liberators, and

problem solvers. This says Momoh (2020), is a paradigm of *African inferiority* in science and technological life which is widely taught in Africa and beyond. Thus, (today) Africans believe that there is little of value in themselves and in their technological past. They have been disarticulated from their race, history, and social conditions.

Europeanization of nature

Findings also reveals, science education appears as *a process of Europeanizing nature*. In Biology for instance, students are trained to classify animals, plants, fungi etc. In all these chapters, students are supposed to understand *nature* through European window, namely *scientific* classification/names. In Biology form four, for instance, chapter one introduces these young scientists on plants classification (Kingdom Plantae). In this topic, plants are divided into four groups namely *bryophyte, filicinophyta, coniferophyta* and *spermatophyta*. This means, Tanzanian students have to try as much as possible to arrange types of plants they know in these 'scientific' groups. It implies then, if the plant does not fit in these groups, it is 'not scientific'. During colonialism in Africa, Europeans tried as much as possible to fix African plants and animals into these 'scientific' names (linguistic imperialism). However, the task was so difficult as in many instances African vegetation differ from European counterparts. Here Tansley and Chipp (1926) say:

> When we try to fix too rigid a framework on the facts of nature we always come to grief because nature refuses to be bound by our conceptions. The wanderings and combinations of plants are so manifold and conditioned in so many different ways that it is not easy to frame a really natural classification of the multiform communities they produce. It is probably impossible to frame one that will fit all the facts. (Hornby and Hornby in Lewis, 1943, p. 25)

This means, Europeans conception of nature (scientific practice) was based on the European context thus failed to accommodate other natural phenomena which were not familiar. Here Tansley and Chipp (1926) provides the problem of grouping some types of plants in Mpwapwa, just a small area of Tanzania; given the size of Tanzania and varieties of plants, how was it possible to accommodate all the plants in European conception? Despite this challenge, in secondary schools, students are supposed to comprehend this European conception. However, when they (selected students) were asked to classify their environment using available plants in school and at home grounds, these students were unable to do so.

From my observations, *Muarobaini*, *mkwaju, muembe* are common plants in these schools and Kinondoni municipality in general, but these students failed to classify using scientific classification taught in class. They are also unfamiliar with the *traditional* classification (classifying plants according to their utility) of the plants. However in In-depth-Interviews with some of their parents (not so much exposed to modern science), when this question was asked most of them managed to classify traditionally; plants for medicine, for building houses, for boat making, for poison, for food. None of the students managed to mention common medicinal plants (as identified traditionally in Kinondoni), despite being surrounded by *miarobaini* and *mikwaju*. In interviews and focus group discussions for instance, students replied:

> I don't know the plants, for what use? That is well known by traditional healers… it was useful in the past, when there was no hospitals, no doctors… to day people do not use these medicine… may be for traditional healers for some witchery reasons. (FGD/ Students/SS2)

> Nowadays things are much easier, you don't need to take local medicines while there are many pharmacies and Hospitals… if I get malaria, I direct go to hospital, and they will give me some tablets… in this city no one wastes his or her time on trying to understand the efficacy of *miarobaini* or *mitishamba*. (FGD/Students/SS4)

Biological knowledge in this case does not help students to understand their nature (lives). This science implies that what does not fit into European science is *not scientific*, and therefore, there is no need of understanding natural environment using their local frameworks (start from what they know/exists in their communities). This psychological condition imposed in all secondary school science subject disarticulates young scientists from their natural environment and at the end produces disarticulated and colonized scientists. These kinds of Tanzanian scientists communicate with their natural world through European lenses; and at the end fail to understand and transform their local sciences.

Reification of natural science

It was also observed, secondary school science produces a *reified* version of science. The content and theories discussed in Physics, Biology, Chemistry and Mathematics appears as originated from individual scientists such as Isaac Newton, Archimedes (of Syracuse) and Michael Faraday. The social context of sciences, discoveries and innovations is left out of discussion. This provides an impression that the scientists are great, genius, and their works are objective. This also contributes on disarticulating young scientists in Tanzania as they come to believe that the

sciences are general, impartial, and neutral. In turn, this limits their curiosity on their immediate environment and conditions. This was observed during in-depth interviews and focus group discussions with science students in selected secondary schools. Many informants failed to think of inventing contextual relevant sciences as follows:

> I'm taking science subjects so as to become great scientist in the world, I want to make robots ... I will sell all over the world… robots reacts quickly in crisis situation and but may be used also in security and many other places. (FGD/Students/SS4)

These are science students, replaying to a question, why they chose science out of many other specializations. Their aspirations … *to make robots… I will be very rich… you will get money ...* are disarticulated from their social conditions. This implies the students are not conversant with contextual scientific needs of their society. They even don't ask what robots and betting technology will do for Tanzanians? They have learned to be *individual scientists* rather than *social scientists* for social transformation. This *egoistic* science stems from secondary school training as detailed in science textbooks. It appears as if science is not intended to solve "social problems" rather a tool for extending one's self esteem or creating private wealth. This is *inhuman science* (Gorz, 1976) or *bad science* as claimed by Rose and Rose (1976). Teachers and parents of these students made the same reifications as described below:

> Teaching science in secondary schools is very difficult; in this school, only few students take science subjects because the studies are complex despite the good future for those who excel. Science subjects provide students with quick employment in future… you know, science is real. (IDI/Teacher/SS3)

Reification of natural science is a dominant practice in academia. Latour and Woolgar (1986) expose how the laboratory life is full of biases. On natural science, they argue, there is a *social construction of facts*. Scientific findings are a result of discussions, misunderstandings, and consensus between scientific communities, government agencies, funders, and many other stakeholders. In this manner, scientific laws are a collective effort of the *social actors/forces* rather than egoistic, objective, and impartial achievement. Rose and Rose (1976) also show how scientific discoveries are influenced by social conditions of society, they are loaded with class interests and racial prejudice. Newton discoveries as well is based on the social conditions of the time as discussed by Hessen (1971) in the *Socio-economic roots of Newton's mechanics.* Basing on the Middle Ages European social organization,

Hessen highlights three important contradictions namely; contradiction between *nations* (war), between *classes* (bourgeoisie and feudal lords), and between these classes against the *economy* particularly on communication and industry. To this end therefore, it can be argued that science is not an *individual* property or influenced by individual's efforts rather, it is a property of society, reflecting the needs and aspirations of the dominant class. Discussing science out of its social basis produces a reified version of science which prepares learners to disconnect science from their immediate social and environment.

Disarticulated science

Lastly, it was also observed that, secondary school science is *disarticulated* from the existing technologies in Kinondoni. It does not aim to advance existing local science. Students are introduced to theories and calculations which do not contribute directly to advance the level of traditional technologies at their localities (e.g. Traditional boats, hand hoes, traditional medicines etc.). The content discusses sophisticated knowledge which cannot be applied in the immediate environment. For instance, one of the major economic activities in Mbweni and Kunduchi hamlets (within Kinondoni Municipality) is subsistence fishing using traditional boats. These boats have been used for many years and the knowledge is inherited from one generation to the other. However, the traditional boats making technology in Mbweni and Kunduchi localities has almost remained the same despite physics knowledge disseminated to the students. The connection between modern and traditional science is all most nonexistent. One of the parents, a traditional boat maker had this to comment:

> Things are getting worse nowadays, our children reject this knowledge; they are not eager to learn how to make these tools… they have no time, no interest… I don't know what will happen to this generation in the next few years. (IDI/Parent/SS2)

This actually means, modern science, for instance, scalar and vector knowledge has no place in these traditional boats; this implies, students learn physics in order to apply on modern vessels made outside Tanzania (thus, perpetuating dependency). Therefore, secondary school science does not revolutionize the productive forces needed by urban underclass and peasants in their everyday life. This version of science then produces disarticulated young scientists who cannot connect the modern and local scientific knowledge. The response … "*Nowadays things are much easier, you don't need to take local medicines while there are many pharmacies and Hospitals…* and … "*I don't know the plants, for what use? That is well known by traditional healers…"* from Focus group discussions with science students (see

above), confirms this form of disarticulation. Thus, it appears to these students, medicinal plants are things of traditional healers and not *scientific*.

Conclusions

The focus of this paper was on the relationship between natural science knowledge and development of science and technology in Tanzania. It is an attempt to answer the question, why despite of dissemination of modern science knowledge in forms of physics, chemistry, biology and mathematics, Tanzania is still technologically behind? To answer this question, it was necessary to situate Kinondoni and Tanzania in a big picture, to interrogate social forces impeding development of science and technology. In the process it was discovered that, first the underdeveloped state of science and technology of Kinondoni/Tanzania in particular and Africa in general cannot be understood in isolation to the imperialist forces globally. According to the historical facts, these areas were scientifically developed before encountering the European imperial project. It was European imperialism in a form of Colonialism which laid down the foundation of Tanzanian technological underdevelopment. Technological distortions and suppression were done through colonial civilizing mission as organized by the colonial education system among other factors. These structures were inherited by many African countries including Tanzania. Thus, despite the efforts of disseminating and Africanizing science and technology during the neocolonial (*ujamaa)* period, nothing substantial has changed.

Second, in the neoliberal era, (the third phase of imperialism), it was observed that, Tanzania is still facing the same problem. Secondary school science education, in terms of physics, mathematics, chemistry and biology is still disarticulated; schools disseminate Western version of science which function to accentuate the problem. This disarticulation exists in four pillars/forms, that, science appears as a process of Europeanization of the natural science disciplines, Europeanization of nature, reification and disarticulation. The combination of these forms produces a flawed version of science. With regard to this nature of training then, it was observed that, science students at Kinondoni municipality are disarticulated from their own social conditions. The students keep glorifying Western version of science which cannot adequately understand and transform their own; eventually, slow down the efforts of advancing science and technology from below.

To address the situation, stakeholders may start by re-conceptualizing science and technology in the country. This should involve reviewing educational curricular, syllabi and textbooks against the social conditions of Tanzania. This will provide them with the contextually relevant science/technology which stands up against banking knowledge, epistemic colonialism/imperialism and disarticulated knowledge in general.

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