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Quest for Conceptual clarity of Science and Science Education in the context of a Competency Based Curriculum

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Abstract: **This study sought to evaluate the normative implications of science and science education within the epistemic context of 'Scientism'. There is little discourse on whether science and science education are still faithful to mission of and spirit of Scientific Inquiry. Consequently the study employed analytical method to examine the global conception of Science and Science education, to assess the level of genuine science and science Education with the confines of scientism and to construct a conception of science and science education for a Competency Based Curriculum. The study infers that the concept of science needs to be re-examined every time scientific activities are taking place. Continuous reevaluation of science within the confines of science Education is an imperative both at global level and at local level. This is because proper conceptualization is a precursor to proper pedagogy in Science Education.**

Keywords: **Science, Scientism, Science Education.**

1. INTRODUCTION

Introduction

Science as an epistemic force has managed to progressively shape individual, social and political development across the globe. The successes of Scientific Method over time have not only led to its honest appreciation but also to a corresponding prioritization of Science education across the globe. UNESCO (1990) defines Science Education as science teaching in school. According to Holbrook (2010), Science education is 'Education through Science'. This study adopts the definition of Science education as the study of the interrelatedness between any branches of science as a discipline and the application of educational principles to its understanding, learning and teaching (Mbajiorgu, 2019).This implies that science education involves very strong backgrounds in both science and in educational principles meant for understanding of science, its teaching and learning.

Statement of the problem

There is no doubt that science plays a crucial role in overall development of human civilizations across the globe (RoK, 2017., Gok, 2012, Oyeshile, 2007., UNESCO, 2005., Champagne, 2000., IBE, 2000 and RoK, 1982). The efficiency of science and technology in solving social and economic problems has been the main impetuous for the popularization of science in general and specifically science education. Governments spend comparatively higher percentage of their educational budgets in enhancing science education (Oyeshile, 2007 and UNESCO, 2005). However the popularity of science drags a lot with it a problematic psychological disposition and a logical error that overemphasizes, overgeneralizes and overstretches the scope of science. This extremism, also known as scientism stretches back to the period of scientific and industrial revolutions but its blinding effect is becoming more visible in the 21st century (Gasparatou, 2018., Haack, 2016., Sorell, 2013, Ross and Spurret 2007, and UNESCO2005). The impact of scientism on science education is

undesirable. UNESCO (2008) describes scientist exaggerations as a 'well fertilized weed in science education'. The weed labeling of scientism means that it is an unwanted element in genuine science due to its fundamentalism (Haack, 2007) Kenya's Vision 2030, sessional paper No. 14 of 2012, sessional paper No. 1 of 2015 among other policy documents foresaw the birth of not only the new Competency Based Curriculum in Kenya but also a renewed emphasis on science Education. The concepts of Science and Science Education are predominant in the Basic Education Curriculum Framework (Rok, 2017). Scholars in Kenya and abroad have analyzed CBC curriculum from instructional viewpoints, from economic perspectives, and from sociological perspectives but there is little discourse on whether science and its cognate of science education is still faithful to its mission and truth.

Purpose of Study

This study sought to audit science and science education with the epistemic context of scientism.

Objectives

1. To exam the global conception of Science and Science education

2. To assess the level of genuine science and science Education with the confines of scientism

3. To construct a conception of science and science education for a CBC curriculum

2. METHODOLOGY

Analytical Method

Analytic Method was the brain child of the School of Analytic Philosophy whose major axiom was that philosophical problems can only be solved through proper understanding of language (Wittgenstein, 1953 and Ryle, 1949). It occupies itself with breaking of concepts into simplified components that can be easily understood. It thus plays role in clarifications of thought patterns expressed in language. According to Analytic method, Philosophy and Sciences are communitarian endeavors that require cooperation; which is impossible without communication (Bonchenski, 1968). Communication is thus so intrinsic in the process of knowing such that without it no science or philosophy is possible. Ludwig Wittgenstein in his *Tractatus Logico Philosiphicus* noted that Philosophical problems are linguistic Problems (Wittgenstein, 1922). It follows then that the process of communication involves use of signs called words (Verbum, logos). Words are both substantial and material and as such require high level of artistic manipulation (pegged on very high mental activities such as abstraction, contemplation...). Words are also understood by their syntactic, semantic and pragmatic relations (Bonchenski, 1968). They are windows to reality; the clearer they are the more the access they give to reality, because human mind does not physically touch material reality or even immaterial reality except through the process of thinking as motivated by words.

It is therefore in the conviction of the researcher and in agreement with Bertrand Russell that “every philosophical problem when subjected to the necessary analysis and purification is found either to be not really philosophical at all or else to be pseudo-philosophical ...” (Russell , 1912). This reaserch will employ at different stages, different brands of Philosophical Analysis ranging from Conceptual analysis, constructive anlaysis, descriptive analysis, transcendental anlaysis and imaginative analysis to achieve more profound understanding of the problem that Scientism is to educational theory and practice in general but more spceifically to holistic competency education in Kenyan Seconary Schools.

Objective One: To exam the global conception of Science and Science education

UNESCO (2005) obliged policy makers to consider, within whatever funding available, to maximize the number of students in science and technology, and to improve the quality of science education. World Conference on Science and Technology Education (WCSTE) (2007) expressed concern at the lack of recognition of science education as a vehicle for meeting national educational goals, and social and economic needs. The observations by WCSTE (2007) was reiterated the UNESCO's aim of the improving science education and subsequently making it a priority

The launch of Sputnik I by the Soviet Union on October 4th 1957 elicited the reaction of President Eisenhower on the role of United States of America in scientific research. On 24 October 1957, ten days after the launch of Sputnik 1, Eisenhower officially affirmed his regard for science as a new frontier to be explored by humanity. The grand majority of American scientists, naturally, agreed with the President that Sputnik 1 presented a chance to raise public awareness and support for investment in scientific Research (Kennedy, 2005). As a result the United States of America received an extra ordinary

boost in Science education in the 1960 and 1970 after Federal government felt that its perceived preeminence in Scientific Research and its national safety were threatened by the launch of Sputnik 1 (Champagne, 2000). To popularize Science Education, the scientific community in the USA has always called for the broadening of the purpose of Science Education from training professional scientists to include science literate society (Ellis, 2001). A science literate science is looked upon as a strong back up in scientific and economic progress of the USA.

In the United Kingdom Science education is compulsory (Gov.UK, 2015 and Osborn & Poisson, 2000). The e aims of Basic Science Education in the UK are to develop scientific knowledge and conceptual understanding through the specific disciplines of biology, chemistry and physics, to develop understanding of the nature, processes and methods of science through different types of science enquiries that help them to answer scientific questions about the world around them, and to equip learners with the scientific knowledge required to understand the uses and implications of science, today and for the future(Gov.UK, 2015)

On its part, the Chinese government during its National Education Conference of 1999 decided to intensify educational reform and vigorously promoted quality science -oriented education. As result Science Education in China was made compulsory for 9 school years (IBE, 2000) the concept of 'quality-oriented education' aims to optimize the potential of the students, individually and collectively, by providing comprehensive education for societal development (Dillon et al, 2017). As part of comprehensive review it was decide that Science Education be improved and expanded. The Educational reform in China was based on the twin convictions that every student should be scientifically literate and that each can do justice to the study of science.

In Africa, strengthening of Mathematics and Science Education has taken joint inter-regional efforts bringing together Western, Eastern, Central and South African blocks with 34 member countries formed to strengthen Mathematics and Science education. (SMASE-WECSA, 2014). They form professional networks based on action research that is consistent with global trend in science education African Governments through ministries of education make policies that favor the increase of enrolment in natural science and technology related courses (Oyeshile, 2007). Despite the increase in enrolment, Studies shows that a large number of Students seem to learn very little science in schools, learning seems to be by rote and pupils find learning science to be difficult while pupils copy/ dub textbooks or old notes (Salau, 1996, Okebukala, 1996, Uzoechi, 1996). Uzoechi(2006) and Ifebo (2005) found out that lack of adequate instructional materials and human resources contribute to poor performance in primary science hence low achievement of pupils in the subject. As a result the Nigerian has been allocating more than 60 % of its annual educational budget to Science education and Research Oyeshile, 2007). In Malawi, the government has integrated In-service Teacher Education programme (MIITEP), which has been designed to improve the quality of teaching and learning at all levels of education system. SMASE/WECSA has been embraced to improve quality of teacher content mastery and pedagogical skill in Mathematics and Science education. (Kahn, 2007).

The emphasis of Science Education in Kenya is neatly framed in various government policies and commissions reports. The report of the presidential working party on the second University in Kenya (Mackay report of 1982) recommended the establishment of the 8.4.4 system of education with a strong orientation towards vocational and science education(RoK, 1982).In the constitution of Kenya Science education is paramount because its considered as part of cultural heritage of the nation (RoK,2010, art. 11(2) a) and a crucial means to national development(RoK, art11(2)b). The constitution also emphasizes that scientific research is part of the freedom of expression (Rok, 2010, art 33(1)c).

The discourse on Science and Science education in Kenya was epitomized at a paradigmatic level in 2008 when the government launched its vision 2030 blueprint. In this document the role of science in economic, social and political development is spelt emphatically. Science is considered as part of the foundations of the economic, social and political pillar of vision 2030(RoK, 2008, p.6). As such it proposes an intensified application of Science to raise productivity and efficiency across the three pillars of vision 2030(p. 8). It points out that more resources will b devoted to scientific research, and to raising the quality of teaching mathematics, science and technology in schools, polytechnics and in Universities (p.9). As part of its educational strategy, the Government of Kenya through Vision 2030 asserts that it intends to expand enrolment in universities with emphasis on science and technology courses, to revise curricula of universities and colleges by including more science and technology subjects (p.16)

In its efforts to reform and realign educational and training sectors for the achievement of vision 2030, the government of Kenya, through its sessional paper 14 of 20-12 asserted that the guiding principle in educational reform should be

prioritization of science, technology and innovation(RoK, 2012, p.15). It is anticipated that the post 2030 Kenyan citizen should be bale embrace Science, Technology and Innovation (ST&I) so as to effectively conserve, sustain and exploit the environment. The emphasis on science for posterity would then require that necessary conditions are laid down to ensure that there is effective teaching of science. Technology and ICT t by 2015, provide a curriculum that integrates science technology and innovativeness, establish specialized universities to train undergraduate students only, accelerate enrolment in science courses and to ensure at least 40 per cent enrolment of female students into science-based university academic programs.

Key responsibilities assigned to The Science, Technology and Innovation act of 2013 was to facilitate promotion, coordination and regulation of the progress of science, technology and innovation of the country, to assign priority to the development of science, technology and innovation, and to entrench science, technology and innovation into national production system

The purposes of National Education Sector strategic plan for the period 2018-2022 was to increase access and participation, raise the quality and relevance and improve governance and accountability in education, training and research with an emphasis on Science, Technology and Innovation (p. xii). This plan indicates that the development and application of science, technology and innovation is crucial to the success of national development policies and programmers (p.14) and laments that Universities in Kenya have shifted focus away from Science, Technology, Engineering, and Mathematics (STEM)-based courses.(p.15)

Objective Two: An assessment of the level of genuine science and science Education with the confines of scientism

The popularity and the efficacy of science as indicated in the review above is are clear indications that there is no doubt that science and science education must be embraced by all nations. On the hand the excessive and immoderate emphasis of science that accompanies legitimate popularization of science is a liability to science itself and to science education(Gasparatou. 2018).Literature reviewed in this section pinpoints over emphasis in science from the United states(with kneejerk reactions against Sputnik 1 as the basis of science), United kingdom and China with emphasis on content dimension of education, with Nigerian and Malawian imbalance education expenditure and with Kenya's massification of policy documents on science and science education.

An overemphasis on science and science education at the expense epistemic balance leads to the fallacy of *Scientism* According Merriam Webster dictionary, the term scientism was first used in 1870 as a compound noun from science (from the ancient Latin, sciatica, scire) the suffix -ism referring to prejudice. The compound noun scientism thus referred to belief in the capacity of science to solve all problems. While the conceptualization of term goes back to 1870, its meaning precedes it. According to Voegelin(1948), the -ism in science began in seventeenth century in a fascination with the new science(also known as mathematized science) to the point of underrating and neglecting the concern for experiences of the spirit; developing into the assumption that the new science could create a world view that would substitute for the religious order of the soul. Epitome of scientism culminated, in the nineteenth century, in the dictatorial prohibition, on the part of scientistic thinkers, against asking questions of a metaphysical nature(Comte, 1830). Phenix (1961) defines scientism as the viewpoint that "...all significant knowledge is scientific....that....nothing except science is real or valid knowledge" Hutchinson,(2011) regards Scientism as a speculative, psychological, dogmatic and attitudinal worldview based on the assumed supremacy of natural science Popper(1979) defined scientism as "the aping of what is widely mistaken for the method of science" while Hayek(1980) who defined it as the "slavish imitation of the method and language of Science". Stenmark (2003) proposed the expression *scientific expansionism* as a synonym of scientism. According to Burnett (2013), Scientism is the sum total of efforts to extend Scientific ideas, methods and practices to matters of human, social and political concern.

The undesirability of the fallacy of scientism is characterized by UNESCO (2005) as a well fertilized *weed* in science education. As a follow-up, UNESCO's World Commission on the Ethics of Scientific Knowledge and Technology (COMEST, 2008) indicated in its declaration in Bangkok declaration , that it is necessary to pronounce the fundamental values of science and scientific research. The problem of the fallacy of Scientism is that it easily masquerades as *respect for science* while it real sense it's an *idealization and deification of science(*Gasparatou, 2018, Peels 2017, DeRidder 2014, Kitcher, 2012;Van Woudenberg, 2011.; Haack, 2007; Stenmark 2001, Sorell 1991). To mark the difference between

legitimate respect for Science and idealization of science(also scientism), Hutchinson(2011) posits six criteria of science and Haack(2007) elucidate six sigh of scientism. Hutchinson(2011) observes that genuine science is based on universal and standardized criteria of Science that is; consistency, observability, naturality, predictability, testability and tentativeness . On her part Haack(2007) lists six criteria of scientism. First is scientistic honorificationism, which refers to using the words "science," "scientific," "scientifically," "scientist," honorifically, as generic terms of epistemic praise. Secondly is classicalism refers to adopting the manners, the trappings, the technical terminology of the sciences, irrespective of their real usefulness. Thirdly, Scientistic demarcationism which refer to the preoccupation with demarcation or with drawing a sharp line between genuine science and "pseudo-scientific" impositions. Fifth, methodism points to the preoccupation with identifying the "scientific method," presumed to explain how the sciences have been so successful. Lastly, Pontificationism involves looking to the sciences for answers to questions beyond their scope while Scientistic imperialism involves denying or denigrating the legitimacy or the worth of other kinds of inquiry besides the scientific.

Kenya's Competency Based Curriculum(CBC) is being implemented at a time when fallacy of scientism is hardly detectable to the public and to the educational stake holders, who like the rest of global citizens, believe without doubt that science is the real thing. The Basic Education Curriculum Framework (BECF) of 2017 observed that the content and implementation of 8:4:4 curriculum was academic and examination oriented (RoK, 2017), and so unfit for the realization of vision 2030. The Framework engendered a Competency based curriculum aligned to the Constitution of Kenya, Vision 2030, the East African Community Curriculum Harmonization Structures and Framework, and other policy documents that express the aspirations of the country(p.3) BECF lays a very strong emphasis on Science education. On face value the concept science and its cognates appears 202 times in the document and the first time it occurs in the main section of the document it emphatically affirms the scientific aspirations of Kenya Vision 2030 and Sessional Paper No. 2 of 2015 which laid a strong emphasis on the importance of science, technology and innovation The framework posits the role of science in promoting critical thinking and problem solving skills, and in mitigating unemployment challenge in Kenya.(Pg. 24). Special emphasis is laid the pathway of Science, Technolology, Engineering and Mathematics(STEM) through appeal to Sessional Paper No.14 of 2012 which states that in order to achieve the desired economic growth, social development and political maturity, high priority will be placed on the development of human capital through education and training by promoting and sustaining basic and higher education, and technical and vocational training with an emphasis on Science, Technology and Innovation (ST&I). The framework also points out that the pure and applied sciences curriculum shall prepare learners to graduate with a senior school national certificate that will open career opportunities for them. The logical frame work of CBC in general and of its conception of science education is inherent its vision and mission , and in the aims science education The vision of the basic education curriculum reforms is to enable every Kenyan to become an engaged, empowered and ethical citizen while the mission is to nurturing every learner's potential'(RoK,2017, P.10). Science education in the BECF is defined as the practice of engaging with the human pursuit of knowledge in order to understand relationships within the living and non-living universe, and as the mother of invention (RoK, 1917, p.38). At lower secondary level integrated science education combines concepts of physics, chemistry, biology and environmental studied and provides the learner with an opportunity to gauge his or her ability in science in preparation for studying the same at *higher levels* and even choosing it as a career. Rok(2017, p.61) asserts that at upper secondary, the STEM pathway will aim at developing the individual learner's innovativeness and promoting the use of technology to develop a labor force that will drive the Kenyan economy.

3. Conceptualization of science and science education for a CBC curriculum

Ong'owo and Indosi (2013) assert that the goal of science education is to enhance all students' scientific literacy which involves grasping essential science concepts, understanding the nature of science, recognizing the relevance of science and technology , and progression of science studies beyond the school.The and the vision of CBC as a expressed in BECF are action oriented , the conception of science education at primary, at lower and upper secondary seems to emphasize of concept acquisition and postponed of the scientific methodology of science up to upper secondary. It also appears that the main aim of science education is vision 2030's plan for a labor and career. (p.10, p.38, p.61). On the other hand, the theoretical frame work heavily cites theorists that might not be in tandem with the document' s conception of science education. BECF enlists Perkins, (1992), John Hattie (2012), Dewey, Vygotsky, Piaget, Brunner, Gardner and Hattie, Piaget, Brunner, Erikson as the fundamental theorists that inform the foundation CBC. Of all the theorists the most cited

is John Dewey (19 times) across the BECF followed by Vygotsky(15times) then Piaget(12times), then Gardner(10times) and the rest less than 4 times.

Consequently, John Dewey's theory science education becomes critical in illuminating BECF's conception of science education in relation to genuine science and in assessing scientist signs in CBC. Dewey's theory of science education. Deweys Philosophy of Science education is an extension of his Pedagogic creed in which he proclaims that science ducation is a synthesis of experiences made possible by human activity and not an exclusively objectified matter

> I believe that education cannot be unified *in the study of science*, or so called nature study, because apart from *human activity*, *nature itself is not a unity*. I believe that one of the greatest difficulties in the present teaching of science is that the *material is presented in purely objective form, or is treated as a new*, peculiar kind of experience which the child can add to that which he has already had. In reality, *science is of value because it gives the ability to interpret and control the experience already had* (Dewey, 1897., P4)

He further argues in his creed that education is life, and if it is life then science education should be emanate from and culminate into experiences of the learner with openness to further experiences

> I believe that there is, therefore, no succession of studies in the *ideal school curriculum*. If education is life, all life has, from the outset, a scientific aspect, an aspect of art and culture, and an aspect of communication. It cannot, therefore, be true that the proper studies for one grade are mere reading and writing, and that at a later grade, reading, or literature, or science, may be introduced. I believe that education thus conceived marks the most perfect and intimate union of science and art conceivable in human experience (Dewey, 1897., pp5-7)

Therefore, according to Dewey (1920, p. 89) science means the invasion of the unknown rather than the repetition in logical form of the already known. It is the endless and persistent uncovering of facts and principles rather superstitious memorization. He further observes that a reconstructed philosophy that underpins Science education is not only a product of science itself should but should also enable men to recognize the claims of reason without at the same time degeneration g into a paralyzing worship of *super empirical authority* or into an offensive rationalization of things as they are those who respect the past and those who are interested in establishing a happier future (Dewey, 1920, p.102). Further, it can be inferred that according to Dewey(2001) instruction in Science should .follow the Psychological as opposed to the exclusivist logical approach. Dewey asserts that the Psychological model of science education secures the interest of the learner, emphasis scientific methods, and proceeds from inductive logic and helps to avoid mental confusion and intellectual distaste of too much symbolism in science.

3. CONCLUSION

The concept of science needs to be re-examined every time scientific activities are taking place, Most importantly a continuous reevaluation of science within the confines of science Education is an imperative both at global level and at local level. This is because proper conceptualization is a precursor to proper pedagogy in Science Education.

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