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Abstract

This study explores the implications of John Dewey's concept of experience on Nigeria's quest for scientific and technological progress. Dewey's philosophical framework emphasizes experiential learning, active engagement, and problem-solving, aligning with the country's need for innovative and entrepreneurial mindsets. Nigeria faces significant scientific and technological development challenges, including inadequate infrastructure, limited access to quality education, and a shortage of skilled professionals. Dewey's concept of experience offers a compelling solution, prioritizing hands-on learning, critical thinking, and creativity. Using a qualitative research approach grounded in philosophical inquiry, this study draws on Dewey's pragmatist philosophy and Nigerian educational context. The findings highlight the potential of Dewey's concept to transform Nigeria's education system and drive scientific and technological progress. Dewey's concept of experience has significant implications for Nigeria's education system, including revitalized education through experiential learning, enhanced critical thinking and creativity, and improved STEM education and scientific literacy. The study's findings have implications for educational policy, curriculum development, and teacher education. Dewey's concept of experience offers a valuable framework for addressing Nigeria's scientific and technological development challenges.

Keywords: Dewey's concept of experience, experiential learning, STEM education, scientific and technological progress, Nigeria.

Introduction

Nigeria's education system faces significant challenges. Education is often viewed as a means to acquire certificates for better job opportunities and social status, rather than a transformative experience. The current curricula neglect moral education, creating a disconnect between formal schooling and real-life experiences.

John Dewey's concept of experience offers a solution to these challenges. Dewey's philosophy emphasizes civil and moral education beyond academic excellence, advocating for a participatory approach that addresses both formal and informal child education. His concept of experience encompasses a holistic understanding of human existence and interaction with the world, recognizing experience as a communicative, historic, and cultural phenomenon.

Nigeria's National Policy on Education, introduced in 1977, aims to address these challenges. The policy emphasizes scientific and technological development through the 1-9-3-4 system, prioritizing functional education for individual and societal development. The policy's objectives include building a free, democratic, just, and self-reliant nation.

Dewey's philosophy is crucial in achieving these objectives. His ideas influence our understanding of ideal education, stressing individual and societal development. Experience, in Dewey's view, is ultimate reality, encompassing all aspects of life.

To move forward, Nigeria's education system must emphasize research and experiential learning, addressing the defects in scientific and technological progress. By aligning education with Nigeria's national objectives and embracing Dewey's concept of experience, the country can foster a more holistic and effective education system.

Analysis of the Concept of Experience

Experience refers to conscious events in general, more specifically to perceptions, or to the practical knowledge and familiarity that is produced by these processes. Understood as a conscious event in the widest sense, experience involves a subject to which various items are presented. In this sense, seeing a yellow bird on a branch presents the subject with the objects "bird" and "branch", the relation between them and the property "yellow". Unreal items may be included as well, which happen when experiencing hallucinations or dreams. When understood in a more restricted sense, only sensory consciousness counts as experience. In this sense, experience is usually identified with perception and contrasted with other types of conscious events, like thinking or imagining. In a slightly different sense, experience refers not to the conscious events themselves but to the practical knowledge and familiarity they produce. Hence, it is important that direct perceptual contact with the external world is the source of knowledge. So an experienced hiker is someone who has actually lived through many hikes, not someone who merely read many books about hiking. This is associated both with recurrent past acquaintance and the abilities learned through them.

Many scholarly debates on the nature of experience focus on experience as conscious event, either in the wide or the more restricted sense. One important topic in this field is the question of whether all experiences are intentional, i.e. are directed at objects different from themselves. Another debate focuses on the question of whether there are non-conceptual experiences and, if so, what role they could play in justifying beliefs. Some theorists claim that experiences are transparent, meaning that what an experience feels like only depends on the contents presented in this experience. Other theorists reject this claim by pointing out that what matters is not just what is presented but also how it is presented.

A great variety of types of experiences is discussed in the academic literature. Perceptual experiences, for example, represent the external world through stimuli registered and transmitted by the senses. The experience of episodic memory, on the other hand, involves reliving a past event one experienced before. In imaginative experience, objects are presented without aiming to show how things actually are. The experience of thinking involves mental representations and the processing of information, in which ideas or propositions are entertained, judged or connected. Pleasure refers to experience that feels good. It is closely related to emotional experience, which has additionally evaluative, physiological and behavioral components. Moods are similar to emotions, with one key difference being that they lack a specific object found in emotions. Conscious desires involve the experience of wanting something. They play a central role in the experience of agency, in which intentions are formed, courses of action are planned, and decisions are taken and realized. Non-ordinary experience refers to rare experiences that significantly differ from the experience in the ordinary waking state, like religious experiences, out-of-body experiences or near-death experiences.

Experience is discussed in various disciplines. Phenomenology is the science of the structure and contents of experience. It uses different methods, like epoché or eidetic variation. Sensory experience is of special interest to epistemology. An important traditional discussion in this field concerns whether all knowledge is based on sensory experience, as empiricists claim, or not, as rationalists contend⁵. This is closely related to the role of experience in science, in which experience is said to act as a neutral arbiter between competing theories. In metaphysics, experience is involved in the mind–body problem and the hard problem of consciousness, both of which try to explain the relation between matter and experience. In psychology, some theorists hold that all concepts are learned from experience while others argue that some concepts are innate.

Concept of Dewey's Experience

In essays in experimental logic, Dewey defined experience as “the manifestation of interactions of organism and environment.” Dewey used the term “dynamic” to describe experience. He meant it in two senses. One indicates the pervasive quality that binds the elements of experience into continuous whole. Another, he also means that the elements that are in tension and conflict are also called dynamic that is, they are striving to formation of the whole and restatement of the parts. They are continually moving to recover the equilibrium that was lost. Experience is not solely derived from introspection but rather from a transaction with nature. It is clear here that Dewey rejects any dualistic view between individual and the world. He has even remarked “an organism does not live in an environment but it lives by means of an environment.” In other words, experience is an interaction or transaction between organism and environment such that a state of satisfaction or equilibrium is achieved. In this sense, it is not purely formal, that is it does not deal with things that go on exclusively in the mind, and it arises out of concrete situations. A positive quality runs through all elements of experience giving it unity and settlement. Experience significantly connotes space and time which are necessary preconditions of human activity. As he wanted to recover the true spirit of philosophizing he saw experience as the point of

departure. Empiricism has already put experience into the center of attention. However, the criticism of Dewey is that experience was just made as the basis of knowledge and experience became compilations of thought. Relevant points were highlighted by him to be evaluated. First, experience, as he observed it is regarded first as a knowledge affair. This he could not accept because if one looks into the depth of it, surely it will be that it is an intercourse of a living being with its physical object. The use of intercourse here by Dewey would imply that there is an active unity within the person and the object. Second, experience is understood in the confines of subjectivity and physicality. He then, countered for its objectivity which is true to every human endeavors. Third, experience is essentially tied up with the antecedent event. In this kind of understanding he sees nothing or little openness of experience towards the future. Experience must then be understood with being essentially experimental. In this way experience will lead us to look ahead and change what is given. In this way, he understood experience as not something passive but active. Fourth, experience is usually seen in terms of particular events. The way Dewey understood experience is in terms of connections. As the subjects engages in the environment there could never be one but a continuous engagement. The environment continually offers new settings where the subject strives to take control. Lastly, experience and thought were understood to be always in contradiction. It was overshadowed by the idealism and empiricism. However, experience also needs inference. It is, in fact, full of inference.

Dewey repudiated the traditional idea of experience found in modern empiricism precisely because he was loath to believe that intelligence could be driven for long by bad or silly intentions. Instead of defining experience as being composed of our private sensations, he defined it as a psycho-physical process of doing and undergoing. We do something, then we undergo and reflect on the consequences, and this process is the internal dynamic of learning that, in Dewey's view, works to undermine unsavory and stupid motives as much as to help us decide what we should do next. We use our intentions to interpret our experience and guide our actions. But our intentions will usually be assessed and transformed in the light of their results. At least for Dewey, this is what happens when we trust and use intelligence. In the words of Park, "Dewey's concept of experience allows a holistic approach to education, in the sense that it is based on the interaction between the human being and the world. It takes all sides of human existence, its being in the world, as the methodological point of departure. Experience is a central aspect of this interaction and thus a communicative, historic and cultural phenomenon rather than an individual or mental one."

It was not in the mind of Dewey to just let the children experience for the sake of experiencing. They are not left alone to do things on their own and experience things that they want to experience. Park, one primary function that education has is "to make experience more disciplined." Teacher plays an important role in Dewey's educational theory. Teacher's is considered as the "map makers" in Dewey's terminology. It must be clear on their part as to where they are leading the students but not to the point of giving them all the answers. In other words, the teachers must possess the end in view.

The Purpose of Science and Technology Education

Science education is akin to a bridge connecting diverse fields of knowledge. It fosters an interdisciplinary approach, encouraging collaboration and integration of ideas. By engaging with subjects like physics, chemistry, biology, and environmental science, learners develop a holistic perspective that enables them to tackle complex global challenges like climate change, resource depletion, and public health crises. Science education is the process of teaching and learning about scientific concepts, principles, methods, and applications. It aims to develop students' scientific literacy, critical thinking skills, and interest in science. Science education provides a strong foundation for future scientific careers and helps individuals become informed citizens capable of making rational and evidence-based decisions¹. Effective science education includes both content knowledge and the development of scientific inquiry skills. It involves hands-on experimentation, observation, data analysis, and communication of scientific findings. By engaging in scientific practices, students learn to think like scientists and develop problem-solving skills. Engaging students in science education has numerous benefits. It promotes a better understanding of the natural world, fosters curiosity, and helps students develop a growth mindset. It also cultivates skills such as critical thinking, creativity, communication, and collaboration, which are valuable in various career paths.

Research indicates that effective science education positively impacts student learning and achievement. A study conducted by Zoller and Pushkin² found that students who experienced an inquiry-based science curriculum significantly outperformed their peers who were taught using traditional methods. Similarly, another study by Luft³ demonstrated that students engaged in hands-on activities and inquiry-based learning had higher achievement scores in science compared to those taught using traditional methods.

Science education also plays a crucial role in addressing global challenges. With the increasing importance of scientific issues like climate change, pandemics, and technological advancements, it is essential to equip students with a solid understanding of scientific concepts⁴. Effective science education helps individuals become responsible and informed citizens who can actively participate in scientific discussions and contribute to society. According to a study by Nadelson and Sinatra⁵, science education plays a crucial role in developing critical-thinking skills, which are essential for success in today's information-driven society. Similarly, a report by the National Research Council⁶ states that a scientifically literate workforce is essential for innovation and technological advancements, which drive economic prosperity.

On the other hand, some researchers argue that scarce funding and limited resources disproportionately affect science education. According to Research America's 2018 U.S. Investment in Research report, many schools struggle to provide adequate laboratory equipment and supplies, hindering students' ability to engage in hands-on scientific exploration. A study by Women in Physics and Astronomy Education⁷ found that students demonstrated more interest and engagement when science education incorporated real-life examples and practical applications. Critics argue that excessive emphasis on standardized testing results in a narrowed curriculum, neglecting the holistic development of students. A

study by Darling-Hammond⁸ concluded that science education has become less prominent due to the prioritization of testing in areas such as mathematics and reading. In the aspect of qualified teachers, some believe that science education suffers due to a scarcity of qualified teachers, leading to subpar instruction and student disengagement. A report by the National Commission on Excellence in Education notably highlighted deficiencies in teacher preparation, emphasizing the need for continuous professional development opportunities.

To enhance science education, educators and policymakers need to focus on several aspects. Firstly, providing professional development opportunities for teachers is crucial to ensure they have the necessary knowledge and skills to deliver effective science education. A study by Banilower emphasized the importance of ongoing professional development programs that align with the goals of science education and incorporate evidence-based instructional practices. Science education is a vital aspect of ensuring a scientifically literate society and promoting the understanding of scientific concepts, principles, and methods. It equips individuals with critical thinking skills and prepares them to tackle global challenges. By incorporating evidence-based instructional practices, real-world applications, interdisciplinary connections, and fostering inclusivity, science education can inspire and empower students to become scientifically literate citizens.

Science education in Nigeria plays a crucial role in shaping the country's technological and economic development. It includes the teaching and learning of various scientific disciplines such as biology, chemistry, physics, and mathematics. Science education holds significant importance in Nigeria for several reasons. It helps in developing critical thinking skills, problem-solving abilities, and fostering innovation. Science education is essential for producing a skilled workforce that can contribute to the country's economic growth and development. Moreover, it equips students with scientific literacy, enabling them to understand and address contemporary issues related to health, agriculture, energy, and the environment.

Science education is a vital component for the future development and transformation of Nigeria. It lays the foundation for technological advancements, innovation, and economic growth. However, the current state of science education in Nigeria is not optimal, which hinders the country's progress. This critical review aims to examine the challenges and opportunities in harnessing science education for future transformation in Nigeria. Science education is an essential component of preparing students for the future, as it equips them with the knowledge and skills required to understand complex scientific phenomena and make informed decisions.

Meanwhile there are several transformational aspects that can redefine science education involvement: Emphasis on inquiry-based learning; Integration of emerging technologies; Integration of Interdisciplinary approach to solve complex problems, mirroring real-world scenarios. Focusing on sustainability and environmental sciences that will enable students to become environmentally conscious citizens and contribute to a sustainable future; collaboration and global connectivity and partnerships will expose students to diverse perspectives and enhance their understanding of the global scientific community; ethical

considerations and scientific literacy that will enable students to critically evaluate the impacts of scientific advancements on individuals, communities, and society as a whole.

The future transformation of science education involvement is poised to revolutionize the way students learn and engage with scientific concepts. Through inquiry-based learning, integration of emerging technologies, interdisciplinary approaches, and a focus on sustainability, students will be better prepared to navigate and contribute to an ever-evolving scientific landscape.

There has been efforts channeled at improving science education in Nigeria. The Nigerian government has taken steps to address the challenges in science education. The Federal Ministry of Education has introduced policies such as the Universal Basic Education (UBE) and the STEM Education Policy to enhance the quality of science education. Efforts have been made to improve teacher training programs in science education. The government and non-governmental organizations provide professional development courses and workshops to enhance the skills and knowledge of science teachers⁹. Nigeria has collaborated with international organizations like UNESCO and UNICEF to improve science education. These collaborations involve the provision of textbooks, equipment, and training for science teachers. Despite the challenges, science education initiatives in Nigeria have shown positive outcomes. For example, the introduction of the UBE program has led to increased enrollment in primary and junior secondary schools. It has also contributed to the availability of science laboratories in schools¹⁰. Furthermore, teacher training programs have helped develop the skills of science teachers, leading to improved teaching methods and increased student performance¹¹. Science education in Nigeria is of utmost importance for the country's development. Addressing challenges such as inadequate infrastructure, lack of trained teachers, and outdated curriculum are crucial for enhancing the quality of science education. Government initiatives, teacher training programs, and collaborations with international organizations have shown promise in improving science education in Nigeria.

Nigeria is a country with enormous potential for scientific and technological development, but it faces many challenges in harnessing its human and natural resources for the benefit of its people and the world. The problem of science education in Nigeria is multifaceted and complex, involving issues such as inadequate funding, poor infrastructure, low quality of teachers and curriculum, lack of motivation and interest among students, and socio-cultural barriers. These factors have contributed to the low performance of Nigerian students in science subjects and examinations, as well as the low participation of Nigerians in science-related careers and innovations. This situation has serious implications for the future transformation of Nigeria, as science and technology are essential drivers of economic growth, social development, and environmental sustainability.

The Current Trends in Science Education in Nigeria

In recent years, Nigeria has been making efforts to improve science education to align with global agendas such as the United Nations Sustainable Development Goals (SDGs). Here are some current trends in science education in Nigeria and how they relate to the SDGs:

- 1. Increasing focus on STEM education:** Science, Technology, Engineering, and Mathematics (STEM) education has gained significant attention in Nigeria. The government and various stakeholders have recognized the importance of STEM subjects in driving technological innovation and addressing societal challenges, in line with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 4 (Quality Education). Efforts have been made to improve teaching methods, curriculum development, and infrastructure to promote STEM education in the country¹².
- 2. Engaging with digital learning tools:** Nigeria has been exploring the use of technology and digital tools to enhance science education. Online platforms, virtual laboratories, and educational apps are being integrated into classrooms, helping to bridge the resource gap and improve access to quality education, supporting SDG 4 (Quality Education). This trend has been particularly accelerated by the COVID-19 pandemic and the need for remote learning solutions¹³.
- 3. Encouraging girls' participation in science:** Nigeria is striving to increase girls' participation in science education. This aligns with SDG 5 (Gender Equality) and SDG 4 as it promotes equal access to quality education. Special initiatives, scholarships, and mentorship programs are being implemented to promote gender equity in science education, as girls have historically been underrepresented in STEM fields.
- 4. Emphasizing practical and experiential learning:** There is a shift towards more practical and experiential learning approaches in science education in Nigeria. This aligns with SDG 4 and SDG 12 (Responsible Consumption and Production) by promoting critical thinking, problem-solving skills, and sustainable practices. Hands-on laboratory experiments, field trips, and real-world projects are being encouraged to provide students with practical experiences that enhance their understanding of scientific concepts. By embracing STEM education, incorporating digital learning tools, promoting gender equity, and emphasizing practical learning, Nigeria's current trends in science education align with global agendas such as the United Nations Sustainable Development Goals. These efforts are crucial for fostering innovation, addressing socioeconomic challenges, and ensuring equitable access to quality education.

Role of Science and Technology in Education

No economy has ever become developed with this skew in their system of education and training for national manpower supply and/or human capital development. The utter disregard for science and technology education as an instrument of development has caused incalculable damage to our corporate existence. The problems of mismanaged economy, mass unemployment, collapse of health and educational services, insecurity, inflation, collapsed infrastructure, etc can all be traced to the inadequate attention paid to science and technology in Nigeria. It is the lack of science and technology initiative by Nigerians that has led people to turn their energy to the lust for power, greed and self destruction. Sadly enough, every Nigerian finds every other person guilty as charged, except himself or herself.

Government's policy on education has among other issues emphasized but not driven the following objectives:

- a) The training of the mind and the acquisition of appropriate skills, abilities and competencies-both mental and physical as equipment for the individual to live and contribute to the development of the society.
- b) Ensuring that all schools are properly equipped to promote sound and effective teaching, and in particular, that suitable textbooks and libraries are provided for school. Secondary education should be six-year duration and be given in two stages, a junior secondary school stage and a senior secondary school stage. The junior secondary school (3-year duration) will be both pre vocational and academic. It would be free. The senior secondary school would be for those able and willing to have a complete six-year secondary education.
- c) A greater proportion of education expenditure would be devoted to science and technology and a greater attention paid to the development of scientific orientation. However, it is common knowledge that three decades after these objectives were set out to improve the standard of education in the country, not only have none of the objectives been realized, but also the standard of education has fallen far below what it was before.

Science and Technology Education in Line with Dewey's Concept of Experience for Sustainable Development in Niger

Primarily, education is important because it renders the individuals more efficient in their condition of life. Thus, it could be deduced that, the training of individuals collectively in the management of their private affairs would bring about the installation of true ideologies of citizenship and service for nation building. Therefore, education serves as a catalyst both for the individual's self-actualization, natural development, and international relations. However, many have pointed out some of its relevance as far as human knowledge is concerned in all his endeavour. Dewey's concept of experience education therefore, may be visualized as a process of self-realization. Hence, education is an all round drawing of the best in the child and man-body, mind and spirit. In other words, it means leading out the inborn powers and potentials and enabling the child to become what he is capable of becoming. Therefore, self-realization implies development of individuality in the child. Dewey directed his attention at harmonizing the school and the community. He saw the school as an extension of the society and therefore stressed that teachers should help to discover how the children learn and help them.

Education for Dewey is a life process. Hence, the educated person should be able to apply his/her experiences in future life encounters. This continuation or application of experiences acquired in the process of education to future experiences makes education a dynamic phenomenon. Dewey's philosophy and educational ideas have provided guidance to schools, societies, teachers, learners, curriculum planners, the aim, method and techniques of teaching. Dewey's education has much relevance in the innovation and initiation of child-centred education, the role of the environment on the child's education, the school as part of the

socializing institutions, integrated education policy, broad curriculum, introduction of core subjects, skill acquisition, learning from known to unknown (simplification method) etc.

Certainly, education (especially in developing nations) is still caught up in the web of some reasonable problems which are both incoherent with and antithetical to its growth as well as to the fostering of nation building. It is very obvious that most countries' educational system suffer from epileptic fits, characterized by rather half-hearted implementation strategies and followed by lack of political will and sustainable strategies for providing qualitative education. Such facts and factors that strongly militate against pragmatic education and nation building include: economic/poverty factor, lack of well-trained teachers, the influence of tribalism and gender Inequality

The study of philosophy is not to know what men have said, but what the truth of a thing is. Therefore, it would be an unpardonable and a colossal oversight to undertake an interpretation of any philosophical idea or phenomenon without some sort of critical evaluation and appraisal. It is based on this fact that I set out to critically evaluate the major themes in Dewey's philosophy of education that were raised and treated in this work. John Dewey, an American Philosopher, educator, gave recourse to the concept of pragmatism which in his view, was and has always remained the most effective means of solving man's numerous and multifaceted problems. According to him, the problems of man have always emanated from life's situations that have bedeviled the human society. Basically, Dewey undertook to solve the teething problem of the poor standard of education engendered by the traditionalist mode, both of imparting knowledge and of learning. This he did through the instrumentality of pragmatism, while enunciating and implementing it under the following sub-topics.

- **Democracy and Education:** Welding one to the other, Dewey made a powerful thrust into the field of learning with both concept. Thus, under the aegis of pragmatism as his "terminus ad quo" as well as the "magna carta" for development in the society, Dewey perceptively viewed democracy not only as a form of government but also as a way of life. With this in mind therefore, he advocated the introduction of democracy into every sector of the society (one of which is the educational sphere) in order to enhance maximum development. Systematically, Dewey envisioned his system of education as norms for human development. Hence, he noted that education is the mechanism for reconstructing and reorganizing the society as well as realizing the talents and potentialities that lie latent in the child as an individual. Thus, education is "life itself". Consequent upon this, it must be acquired in an atmosphere that is most suitable and beneficial to the educant. This however, explains his emphasis on the maximization of the curriculum for the enhancement of the proposed child-centred progressive system of education.
- **The role of the teacher and the importance of the curriculum:** Although he recognized the indispensable role of the teacher in the education process, Dewey strongly de-emphasized all forms of authoritarianism. Thus, for him, any form of authoritarianism would most certainly not give room for creativity, which the

progressive system of education signifies. Therefore, he advocated an activity packed curriculum which would involve flexibility both in method and in style. This, he called “open-ends and needs curriculum”. This sort of curriculum he affirmed would enable the child to explore and discover knowledge by himself albeit under the tutelage and direction of the teacher. Finally, Dewey noted that the child having acquired this knowledge would be useful not only to himself or herself but also to the society at large. Having evaluated some of the strong points marshaled out in Dewey’s philosophy of education as regards nation building, it behooves on us to point out some of the loopholes that have been conspicuously noticed in his philosophy of education. Man as it were, is a psychosomatic entity; in other words, he consists of body and soul and as such, pragmatic education must not fail to acknowledge this reality: in that it must see to it that knowledge is being imparted in a manner that is most adequate or that accommodate the psychosomatic nature of man.

According to Hutchins¹⁴, education should provide for the perfection of man’s rational and spiritual faculties. However, Dewey’s philosophy of education does not seem to have been explicit on this, as it subtly glosses over it. Equally, Dewey’s philosophy of education as regards the interest of a child, if not properly applied, might in the long run be detrimental to the society’s needs and interest. Indeed, it tends to leave out some salient or important aspects of the child or reality. Therefore, undue concentration on both the real and imaginary needs of a child must be guarded against for the sake of national consciousness and sustained nation building. Furthermore, the metaphysical aspect of man was neglected by Dewey. This is because the experimental reality is only a part and not the whole reality. To deny totally the metaphysical and supernatural dimensions of reality is not an acceptable philosophical stand. Thus, all generations of humanity always explain man’s needs and goals not only in the physical and social but also in terms of metaphysical or supernatural perspective. Nevertheless, it is only in the light of the aforementioned areas that any case of misapplication might most probably expose the lacunae that lie hidden in Dewey’s philosophy of education.

Science could be described as “a systematic and controlled extension of common sense”. Common sense is “a series of concepts and conceptual schemes satisfactory for the practical uses of mankind”. The implication therefore, is that science and technology depend on theory building in the development of techniques. A theory is a set of inter-related constructs or concepts, definitions and proposition that present a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting the phenomena. What is note-worthy is that ‘theory’ upon which science and technology seems to build their foundation is also a concept that is an idea.

Science and technology, though knowledge obtained by observation and testing of facts, appear to be idealistic in nature. Callahan, described how engineers at the time of Galileo knew many facts about pumps which no physicist could explain. According to him, before physics was able to make any important practical contribution to the construction of pumps, it had first to develop an explanation for the facts already known or

implicitly assumed in the engineering operation of the period. Once an adequate theory was developed, then the flow of knowledge began to run from pure to applied science rather than the reverse.

Callahan appears to have seen the inevitability of theories in any scientific and technological advancement and also the place of Idealism in the scheme of things hence he went further to suggest that: “in the development of testing techniques, tools, machines, etc., there is always a move on the intuition of early idealists philosophers”. What Callahan seems to be saying is that the mind is always in a high charged action way and is always looking for connection, for unseen likeness in these circumstances. It is the highly inquiring mind which at the moment seized the chance and turns about what was an accident into something providential.

Being inquisitive is the nature of the inquiring mind. For any scientific or technological discovery to take place, there seem to be the need for a highly active and inquiring mind. Idealism may be likened to imagination. To imagine according to Callahan, means “to make images and to move them about inside one’s head in new arrangement.¹⁵” Callahan rightly pointed out that before any scientific discovery the scientist engages his mind, that is, the rational intellect. The scientist who propounds a scientific theory makes a choice – an imaginative choice which out strips the facts. The creative activity of the scientist or technologist lives in the process of induction understood as the making of hypothetical theories. Every induction is a speculation and it guesses at a unity which the facts presents, but do not strictly imply. An example is the periodic table of Mendeleev and the theory of atomic structure which was created to explain it.

Presenting an article on “creativity and Education”, Gettier, reiterated the inevitability of the Idealists’ world in any creative process. In his explanation of the ‘creative process’, he wrote: “... all one knows is that it is the product of some innately given power related in some intimate but obscure way to our unconscious mind.” For Gettier¹⁶, the creative (imaginative) thinking is a matter of the mind playing round a topic of ideas and allowing the unconscious to make necessary connections between them which give rise to inspiration. Although Dixon¹⁷ admitted his inability to explain how the function takes place in the mind, because, to him it is ‘mysterious’, the fact still remain that any scientific creativeness involves an imaginative leap to a new observable perspective.

According to Gettier¹⁸, some well known experimentalists who believe in scientific method of approach to problem solving, also acknowledge the importance of effective thinking in scientific inquires. These are Darwin and Dewey. For Darwin as well as Dewey¹⁹, ‘effective thinking’ depends on having a store of ideas, Dewey maintained that “our ability to suggest hypotheses for solution depends on a combination of imaginative power and abundant knowledge”. For Dewey, the essentials of thinking include the maintenance of a state of doubt and the conduct of “systematic and protracted inquiry”. Dewey claimed that most of the time, the only recourse for most experimentalists is a choice of alternative conceptions or proposals. Adam, an experimentalist, still holds that an ‘idea’ has a dual function: It prescribes a plan for an action to be performed and makes a prediction of a result which is likely to follow. Adam

is probably saying that an idea, which of course results from thought action, constitutes a process of making inferences from present existences to probable future happenings which involve the use of observable representation of such idea. The experimental method which forms the basis for science and technical education appears to be a controlled procedure in which the inferences are drawn by use of 'reason' and observation.

The mind (intellect) is the active agent which selects, organizes, synthesizes and then conceptualizes what is known. The mind is functional. It is a special activity of an organism that selects and organizes experiences to resolve problems. For the child to reason properly, the mind ought to be developed. Advocating what may be referred to as inquiry-centred, curriculum, Dewey, a pragmatist writes: Processes of instruction are unified in the degree in which they centre in the production of good habits thinking. While we may speak, without error of the method of thought, the important thing is that thinking is the method of an educative experience. Dewey seems to suggest that a teaching-learning process which cannot be organized into the existing experiences of the learner is mere words which do the function of calling out mechanical reaction and regurgitations.

Adam²⁰ observes that for advancement in science and technological education, the acquisition of knowledge should serve as a kind of "bridge for the mind in its passage from doubt to discovery". This should be in form of inquiry and discovery. The process of inquiry and discovery should be rationally or logically inclined. 'Inquiry' should precede 'acquiring', and the teaching of any science, technical or vocational subjects like physics, chemistry, electronics, woodwork, et cetera should not be seen as an end to education, but, an essential ingredient in keeping the educative process alive and going.

To encourage self-reliance in science and technological development or advancement, students ought to encounter challenging problems sufficiently tough and troublesome to cause them to "stop and think". Science involves experience and/or experimentation. This appears to involve the discernment of the connection between what one tries to do and what happens in consequence. This discernment seems to involve some element of thought or reflection.

Experience seems to be reflective, but, some types of experience require more reflection than others. Hence, at the rudimentary stage of science education, like at the primary and junior secondary levels simple trial and error experiences may suffice. This involves mere hunting and picking until one finds something which works; and one may continue with whatever, it is until it fails and then look for something to do. Admittedly, this method proves satisfactory only in relatively routine and trivial matters which do not require much precision, sophistication or intelligence.

At the senior secondary school and tertiary levels where the quality of experience or experimentation moves up in the value scale, science and technical education appear to demand an increasing amount of care, deliberation and thought. When an experience is of such quality that it makes one to hesitate, or stop and 'intentionally' try to discover specific connection of elements, Dewey calls this "a reflective experience par excellence or thinking. It is interesting to note that Dewey, an experimentalist, has a great deal to say about

'thinking', which appears to be the idealists' way of philosophizing. Dewey equates thinking with what makes experience intelligent – what restructures experience by discovering connection. For him, thoughtful behaviour is acting with an end in view. Thoughtful behaviour which involves reflective action, accepts responsibility for the consequences flowing from present action.

Again, Dewey equates thinking with the process of inquiry. Thinking, according to Dewey, is a matter of looking into things or investigating. In reflective thinking, "acquiring is always secondary and instrumental to the act of inquiring". Admittedly, acquired knowledge sometimes appears to be the raw material of thinking, but, thinking seems to spring from situations that are uncertain, undefined or problematic, and it is an act of seeking or a quest for something that is unknown or not yet concrete or not substantial. And this is what is involved in science and technical education. Moreover, thinking according to Dewey, is always hypothetical. However, unlike idealism, the results are never held dogmatically as final. Rather, for Dewey, thinking is a continuous process.

To draw up a connection between experimentation and thinking in science and technical education in order to encourage scientific and technological advancement, Dewey's method of approach to "thinking in education" appears to be of relevance at this point. The description of the method can be made as follows:

1. **State of Experience:** The initial state of thinking is experience. A pupil experiences something by acting upon it, doing something with it. He notes the interaction of his actions, the material acted upon and the resulting consequence. So, to arouse thought rather than mere acquisition of words, the probable first approach to any subject in school – especially science, vocational and technical subjects like biology, chemistry, agricultural science, welding, et cetera should be unacademic or unscholastic as possible. For Dewey, methods which may be permanently successful in formal education, "give the learners something to do not something to learn; and the doing is of such a nature as to demand thinking ..."
2. **Problem:** This situation involves something that is to be done which is new, uncertain or problematic. This problem should be genuine. That is, the question should naturally suggest itself within some situation of personal experience, rather than being a problem only for the purposes of conveying instructions in some school topic. It should arouse thought, observation and also engage experimentation outside school. It should be the pupil's problem rather than the teacher's or text-book's problem.
3. **Formulation of Ideas:** An aspect that is important in thinking is an idea, a guess or an initial hypothesis. This is the creative or idea stage of thinking. According to Dewey, "Ideas ... whether they be humble guesses or dignified theories, are anticipations of possible solutions. They are anticipations of some continuity or connection of an activity and a consequence which has not yet shown itself." At this stage of thinking in education, what is suggested cuts across what is actually experienced. Suggestions predict possible results rather than facts. This is an

invasion of the unknown. Thought in this case appears to be creative. It involves inventiveness.

4. **Observation and Collection of Data:** Dewey believes that it is necessary to have data available to deal with difficulties which arise. In fact, during the thinking process, materials like actions, facts, events, et cetera are very important in science and technical education. Memory, critical observation, thoughtful reading, communication – by way of discussion or dialogue may serve as avenues for the supply of data. At any rate, there should be less reliance on others for data. The student should be given materials that he has to adapt and critically apply to the question in hand for himself.
5. **Reasoned Idea (Hypothesis):** After observations and collection of data, there is need for the formulation of testable hypothesis. Ideas by way of projection, invention, devising et cetera are important in science and technical education. Dewey saw beneath all the varied activities of science the simple theme: Observe, Think, Experiment. Bradbury opined that the thinking stage may be either imaginative (in the formulation of hypothesis) or critical (in the testing of hypothesis). There is the act of mind involved in scientific discovery and proof. The generative act in discovery is 'having an idea' or proposing a hypothesis. One can put oneself in the right frame of mind for having ideas, but, the process itself seems to be outside logic hence, hypotheses have to be tested, that is criticized. This is to see if the consequences correspond to reality.
6. **Experimentation/Testing:** The hypothesis or ideas are tested by acting upon them. Dewey's view is that the learner should be given opportunity to test his ideas by application to make their meaning clear and to discover for himself their validity. Functional education can only be truly sustained by given the student opportunity to come up with his/her ideas and to put the ideas to test.
7. **Conclusion/Report of Results:** If the tested hypothesis effect certain changes in the science world it is accepted as valid. Nigerian Scientists should be encouraged not to shy away from faithfully reporting the results of experimental testing, whether favourable or not. Learners are advised to stop and think, consider the facts of the case and come up with a plan of action brought about by intelligence. This constitutes "thinking" in a reflective experience.

Constraints to Scientific and Technological Progress in Nigeria in Line with Dewey's Concept of Experience

The key issues and challenges faced in science education in Nigeria are multifaceted and require comprehensive solutions to improve the overall quality and accessibility of science education in the country. Some of these challenges include inadequate infrastructure, teacher quality, curriculum relevance, and low student interest and participation in science subjects. There has been a growing public anxiety about the teaching and learning of science in Nigerian schools. The problems of science and technology education in Nigeria are diverse. They arise from inadequate supply of instructional materials, lack of motivation, lack of well-equipped library, lack of workshops, tools and machineries, frequent curriculum changes, lack of well-articulated in-service education programmes, insufficient

university admission for the training of the technology teacher, poor professional, personal and public image, dearth of qualified technical educators. According to the 2010 Nigerian Educational Survey and Digest Statistics (NESDS) report 21% of children ages 5-16 cannot read at all in the South-West compared to 31% in the South-South, 32% in the South-East, 58% in the North-Central, 72% in the North-West and 83% in the North-East. Efforts by the government to deliver free and compulsory education to the Nigerian child at primary and junior secondary school levels through the Universal Basic Education (UBE), has so far been ineffectual. Many public schools lack basic infrastructure and are therefore not conducive for effective teaching and learning.

Outdated curriculum: Pupils perceive school science as lacking relevance. It is often described as dull, authoritarian, abstract and theoretical. The curriculum is often overcrowded with unfamiliar concepts and laws. It leaves little room for curiosity and a search for meaning. It often lacks a cultural, social and historical dimension, and seldom treats contemporary issues.

The difficult Nature of Science: Scientific knowledge is by nature abstract and theoretical. It also often contradicts common sense. It is also often developed through controlled experiments in artificial and idealized laboratory settings. Learning science often requires hardwork and intellectual efforts, (although school science should be tailored to meet the needs and abilities of pupils!) and concentration, which is not part of the present youth culture. In a world where so many channels compete for the attention of young people, such subjects become unpopular.

Inadequate Qualified Science and Technology Teachers: There is shortage of qualified science and technology teachers in many Nigerian schools. Who are often poorly trained. The so called science and technology teachers are not professionally qualified. They may have the knowledge of science but lack knowledge of effective method of teaching²¹. Worst still are the primary school teachers who are jack of all trade.

Stereotypical image of Scientists: Many learners perceive science as stereotypical and problematic. Scientists (especially in physical sciences) many pupils often perceived science to be closed and boring. They are not perceived to be kind or helping and working to solve problems of humankind.

Contradictory and Optimistic Trends: From the falling enrolment in science, one may deduce that there is a falling interest in Science and Technology. While on the other hand, young people are more than ever interested in using all sorts of new technology. It is a paradox that countries which have the most problems with recruitment to science and technology are also the countries with the most widespread use of new technologies among the young people. (Cellular telephone, personal computers, internet etc) There seems to be an eagerness to use the new technologies, but a reluctance to study the disciplines that produce the very same products is alarming.

Science and Technology in Schools: Science and technology education in most countries are criticized for being traditional and rather old-fashioned. The implicit image of science is that

it is mainly a massive body of authoritative and unquestionable knowledge. Most curricula are overloaded with facts and information at the expense of concentration on a few 'big ideas' and key principles. There is often repetition, where the same concepts and laws are presented year after year. Such curricula often lead to rote learning without deep understanding. It should also be noted that science is often seen as demanding and difficult. The ideas are not always easy to grasp. Their understanding often requires concentration and hardwork over a long period of time. The youth of today are not used to coping with such demands. If one should hope for such efforts, pupils will need a strong motivation, and they need to find something that is seen as very valuable. This is not always the case. Although science per se can be seen as difficult, the demands of school science may of course be adopted to suit the age of learners.

Inadequate infrastructure: One major challenge in science education in Nigeria is the lack of adequate infrastructure, such as well-equipped laboratories, libraries, and computer facilities. Without these resources, students may struggle to understand and apply scientific concepts practically. A study by Oyelade and Dapiap22 found that inadequate laboratory facilities were detrimental to science education outcomes in Nigerian secondary schools. To address this challenge, best practices include investment in infrastructure development. For instance, the Osun State government in Nigeria has shown remarkable commitment by providing well-equipped science laboratories in schools. Additionally, organizations like the Federal Government College Odogbolu Alumni Association have embarked on initiatives to refurbish science laboratories to improve science education standards.

Teacher quality: Another significant challenge is the shortage of qualified science teachers. Many science educators lack adequate training and are often assigned to teach subjects outside their area of expertise. This leads to inadequate subject knowledge and ineffective teaching approaches. A study by Ogunleye23 highlighted the low level of teacher professionalism and content knowledge as major constraints to science education in Nigeria. To address this challenge, teacher training programs, workshops, and professional development opportunities are crucial. The Teachers' Registration Council of Nigeria (TRCN) has implemented compulsory teacher certification and re-certification programs to enhance teacher quality24. Similarly, organizations like the Federal Ministry of Education have organized training workshops to improve the skills and knowledge of science teachers.

Curriculum relevance: The curriculum used in science education may not always align with the practical needs of the students and the country. A study by Adeyemi and Soyemi25 revealed that science curricula in Nigeria are often outdated, theory-based, and teacher-centered, which results in low student engagement and limited application of scientific concepts. To address this challenge, curriculum reform is crucial. The Nigerian Educational Research and Development Council (NERDC) has embarked on a process of curriculum review and development to align science education with global best practices and contemporary issues26.

Low student interest and participation: Many Nigerian students exhibit low interest and participation in science subjects primarily due to a lack of practical application, limited role

models, and misconceptions about the difficulty of science. This is evident in the declining rates of students pursuing science-related careers. Addressing this challenge requires a multi-faceted approach. Initiatives such as Science, Technology, Engineering, and Mathematics (STEM) clubs and competitions have been implemented to boost student interest and engagement in science. Notably, the Young Engineers Nigeria Association initiated the STEM Enablers program, which promotes science education through hands-on activities and mentorship. Collaboration between industry professionals, academia, and government is also vital to expose students to real-world scientific applications and career opportunities.

Effective Strategies for the Application of Dewey's Concept of Experience in the Area of Science and Technology Education

The effectiveness of current approaches in aligning Science Education in Nigeria with global agendas such as STEM education, digital literacy, and 21st-century skills is a complex issue. While some progress has been made, there are still several challenges that need to be addressed. Science Education in Nigeria has faced numerous challenges including inadequate infrastructure, lack of qualified teachers, outdated curriculum, and limited practical activities. These challenges have led to a decline in the quality of Science Education and a reduced interest among students in pursuing scientific careers.

STEM education aims to integrate the teaching of science, technology, engineering, and mathematics in a holistic manner. In Nigeria, there have been efforts to promote STEM education, including the introduction of specialized STEM schools and initiatives such as Science, Technology, Engineering, and Mathematics Education (STEM-Ed) seminars and workshops²⁵. However, the implementation of STEM education in Nigeria has been hindered by several factors. These include the lack of infrastructure and resources, inadequate teacher training, and a curriculum that is heavily focused on theory rather than practical applications. These challenges have limited the effectiveness of current approaches in aligning Science Education with global STEM agendas.

As regards digital literacy in Nigeria, there is a growing recognition of the importance of digital literacy. Efforts have been made to integrate digital literacy into the curriculum, such as the introduction of computer science as a core subject in secondary schools⁶¹. However, the provision of digital infrastructure and internet connectivity remains a major challenge in many parts of Nigeria. Without access to reliable internet and appropriate technology, students are unable to fully develop their digital literacy skills. This highlights the need for investment in infrastructure to effectively align Science Education in Nigeria with global digital literacy agendas. 21st-century skills refer to a set of competencies needed for success in the modern world, including critical thinking, communication, collaboration, and creativity. While there is recognition of the importance of these skills in Nigeria, the current approaches to Science Education often do not adequately develop these skills among students. To align Science Education with 21st-century skills, there is a need for a shift from a teacher-centered approach to a student-centered approach that promotes active learning, problem-solving, and creativity. Incorporating project-based learning and inquiry-based

teaching methods can help foster these skills among Nigerian students, thereby better aligning Science Education with global agendas.

Overall, the effectiveness of current approaches in aligning Science Education in Nigeria with global agendas such as STEM education, digital literacy, and 21st-century skills is limited by various challenges. These challenges include inadequate infrastructure, lack of qualified teachers, and outdated curriculum. To address these challenges, there is a need for increased investment in infrastructure, teacher training, and curriculum reform. Only then can Science Education in Nigeria truly align with global agendas and equip students with the necessary skills for the future.

In order to enhance the alignment of science education in Nigeria with global agendas and ensure future transformation in the field, several strategies and policies can be implemented. These strategies focus on improving the quality of science education, promoting equity and inclusivity, fostering research and innovation, and enhancing collaboration with international partners. Here are some detailed strategies:

- 1. Improve teacher quality:** Teacher quality is a crucial factor in improving the quality of science education. Comprehensive teacher training programs should be implemented to enhance the pedagogical skills and content knowledge of science teachers in Nigeria. These programs can include professional development workshops, mentoring programs, and continuous assessment to ensure effective teaching practices.
- 2. Curriculum reform:** The science curriculum should be revised to align with global trends and emphasize inquiry-based learning and critical thinking. This will equip students with relevant scientific skills and knowledge required in the 21st century. The curriculum should also incorporate local contexts and encourage hands-on practical experiences to enhance student engagement.
- 3. Foster research and innovation:** Encouraging research and innovation in science education can significantly contribute to its transformation. Policies should be implemented to provide funding and support for research projects and innovation hubs in schools and universities²⁷. Collaboration between academia, industry, and government agencies should be promoted to facilitate the transfer of scientific knowledge into practical applications.
- 4. Incorporate technology:** Integrating technology into science education can enhance students' engagement and provide access to up-to-date scientific information. Policies should be developed to ensure all schools have access to computers, internet connectivity, and relevant educational software. Teachers should also be trained on effective integration of technology tools into their teaching practices.
- 5. Enhance collaboration with international partners:** Collaborating with international partners can provide opportunities for knowledge exchange, capacity building, and joint research projects. Partnerships with universities and research institutions in other countries can facilitate the sharing of best practices in science education and help Nigeria align with

global agendas. International organizations such as UNESCO and the African Union can play a crucial role in promoting such collaborations.

6. Promote equity and inclusivity: Efforts should be made to ensure that science education is accessible to all students, regardless of their gender, socio-economic background, or geographical location. Policies should be implemented to provide scholarships and financial support to disadvantaged students, promote girls' participation in science education, and improve the availability of science resources in rural areas.

Enhancing the alignment of science education in Nigeria with global agendas requires the implementation of strategies and policies that focus on teacher quality, curriculum reform, research and innovation, technology integration, collaboration with international partners, and promoting equity and inclusivity. These strategies, when implemented systematically, can transform science education in Nigeria and prepare students to actively participate in a rapidly evolving global economy and scientific landscape.

Conclusion

In conclusion, John Dewey's concept of experience offers a transformative framework for Nigeria's quest for scientific and technological progress. By emphasizing experiential learning, active engagement, and problem-solving, Dewey's philosophy has the potential to revitalize Nigeria's education system and foster innovative and entrepreneurial mindsets.

This study has demonstrated that Dewey's concept of experience aligns with Nigeria's developmental needs, particularly in STEM education. By integrating experiential learning into the curriculum, Nigeria can cultivate critical thinking, creativity, and scientific literacy among its citizens.

However, successful implementation requires addressing cultural, social, and economic barriers to experiential learning. Policymakers, educators, and stakeholders must collaborate to create an enabling environment that supports Dewey's concept of experience.

Ultimately, embracing Dewey's concept of experience can position Nigeria for sustainable scientific and technological progress, driving economic growth, and improving the quality of life for its citizens. As Nigeria strives to become a leading player in the global knowledge economy, Dewey's philosophy offers a valuable roadmap for navigating the complex intersections of education, innovation, and progress.

Recommendations

In order to effectively integrate John Dewey's concept of experience into Nigeria's education system and drive scientific and technological progress, the following steps should be taken:

1. Students should actively participate in experiential learning activities.
2. Teachers should integrate experiential learning methodologies into teaching practices.
3. Parents should encourage children to pursue STEM education.
4. Government should Allocate resources for experiential learning infrastructure

Endnotes

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