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Authentic Learning in Science and Technical Education (STE) to Enhance Technologies in Education, Nigeria

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Abstract

The purpose of this study is to discuss the enhancement of technology in education through authentic learning in science and technical education in the case of Nigeria. The authors reviewed numerous academic journals and books on authentic learning, science and technical education in order to support their position. The study is concerned with the challenges of the slow pace of technological development in Nigeria amidst the global burgeoning of science and technology. The authors attributed this problem to the absence of authentic learning in science and technical education in the Nigerian school system. Authentic learning is active learning where students are actively involved in the learning process. The study reviews nine elements of authentic learning with its application to science and technical education as a foundation for quality technologies in education. The paper discusses the relationship between science education and technical education. It concludes that in order to achieve quality technologies in education that match the technological needs of the Nigerian labor market requires authentic learning in science and technical education. The paper also discusses its implications for Nigeria at a national level.

Keywords: authentic learning, science education, technical education, pedagogy.

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Introduction

Technologies in education are in vogue in the 21st century. According to Sayan (2016), educational systems worldwide are under increasing pressure to use information communication technologies (ICTs) to teach students and advance their learning skills. Development is apparent in all sectors of human life. Emphasis is now on the use of teaching resources such as YouTube (Cho, 2013; Jones & Cuthrell, 2011). Today, students learn through applications such as Facebook, WhatsApp Messenger, Skype and other forms of social media (Lamanauskas, Lordache, & Pribeanu, 2017; Shariffuddin, Raihan, Shaaidi, & Hashim, 2016). For instance, there are breakthroughs in human endeavor due to the burgeoning use of technologies in education. As a result of this, there are many technological tools that have made learning more comfortable. The evolvement in technological tools and their utilization has revolutionized different aspects of human life (Tamim, 2013). However, this development has been slow in Nigeria due to teaching and learning problems in both science and technical education. Teaching and learning in Nigerian schools is characterized by crude teaching strategies and learning by rote memorization (Aina & Langenhoven, 2015). Thus, students cannot remember what they were taught or apply it to solve real-life problems. Both the teachers and the students are stereotypical in their teaching and learning. Technologies are dynamic and its evolvement cannot be supported with stereotypical teaching and learning. Teaching and learning have metamorphosed from the traditional chalk-and-talk method to mobile and e-learning. Universities and colleges in most countries are shifting some of their traditional lecture hall classes to online modes of learning (Eik & King, 2012). Students of many advanced countries are information technology savvy and technologically inclined (Shariffuddin et al., 2016). Investigation of countries worldwide with advanced technologies shows that they are not trivial in their approach to science and technical education. Most countries value skills more than certificates, but in doing so requires that education must be made practical.

Education is good only when the learners can practically utilize such education. Science and Technical Education (STE) in Nigeria has not been very successful as many STE graduates are unable to practice their education in real-life situations. Science and Technical education are closely related to graduates acquiring skills appropriate to becoming self-employed. Thus, the idea of vocational-technical education is germane in today's Nigeria. Vocational-technical education is the study of technologies and related sciences, and the acquisition of practical skills and knowledge relating to occupations in various sectors of economic and social life (Oleabihele, Ugbabor, & Erhirhie, 2012). It is an aspect of education which leads to the acquisition of practical and applied skills as well as basic scientific knowledge (Federal Republic of Nigeria, 2008).

The one key advantage of the application of technology in education is that it equips learners with the required skills to function independently after graduation. Nations have recognized not only the positive impacts of technology in education, but also the critical role it plays in securing jobs in the competitive labor market of the 21st century (Jhurree, 2005). Nigerian graduates largely depend on the government to provide employment and where that is not available, they take up alternatives inimical to the national need. Today, the rate of unemployment among school leavers is increasing at an alarming rate. Table 1 shows the unemployment rate among school leavers in Nigeria in 2017. According to the Nigerian National Bureau for Statistics (2017), the unemployment rate in 2017 was 28.1% in the first

quarter, 31.5% in the second quarter, and increased to 36.6% by the third quarter. Unless teaching and learning in STE is corrected to an authentic learning mode, the situation may not improve, but may even worsen in years to come.

Table 1. Unemployment Rate in Nigeria for 2017

Group	1st Quarter (%)	2nd Quarter (%)	3rd Quarter (%)
Never attended school	14.8	16.0	18.6
Below primary school	18.9	20.0	23.2
Primary school	10.3	11.4	13.5
Secondary school	15.4	13.9	16.2
Post-secondary school	16.7	28.0	31.8

Source: National Bureau of Statistics (2017)

Table 1 shows an increase in the rate of unemployment from the 1st quarter to the 3rd quarter of 2017 for all education groups except Secondary school. The most important and worrisome result shown in Table 1 is that the unemployment rate among post-secondary school graduates is the highest among all the groups. In this group are the cohort of the nation's youth which are supposed to be the strength of the future national economy. One primary reason for this might be due to the type of secondary education they received which lacked authentic learning experience. Authentic learning should equip them with skills in technology whereby they could themselves be labor employers rather than seeking low-paid jobs.

Authentic learning is learning by doing. It is active learning. According to Milson (2002), authentic learning is a process of asking meaningful questions, finding information, drawing conclusions, and reflecting on possible solutions. For learning to be real, it must be student-centered; where students determine and direct the learning by themselves. The tasks must have real-world relevance and also require the production of knowledge instead of a reproduction of knowledge (Herrington, Reeve, & Oliver, 2010). Learning of this kind helps students to use classroom learning to solve real-world problem outside of the classroom. In authentic learning, students are actively working, participating in discussions, hunting for information, and therefore more likely to enjoy the entire process of learning (Mims, 2003). Authentic learning activities are designed to give students "real-world" experiences. Educational researchers have found that students involved in authentic learning are motivated to persevere despite any initial disorientation or feelings of frustration (Lombardi & Oblinger, 2007).

Herrington and Kelvin (2007) contended that much of the abstract knowledge taught in most schools is irretrievable in real-life because it ignores the interdependence of situation and cognition. For this knowledge to be relevant and retrievable in real-life, the authors advocated for authentic learning with nine fundamental elements. These elements are; authentic contexts, authentic activities, expert performances, multiple roles and perspectives, collaborative construction of knowledge, reflection, articulation, coaching and scaffolding, and authentic assessment.

The challenge of not adopting the authentic learning model has been integral to the Nigerian education system from the time of the nation's independence in 1960. The reason for this is that Nigerians value certificates more than skills. Thus, people regard technical education in Nigeria as a course for low ability students (Okolocha, 2012). The result of this is that many of the Technical Colleges established after independence are now hideouts for

criminals and even used as homes for various types of animals. However, as a result, the country is paying severely for the mistake with high youth unemployment and other social vices on the increase. Therefore, in order to have enduring technologies in education requires a solid foundation of science and technical education based on authentic learning.

RELATIONSHIP BETWEEN SCIENCE EDUCATION AND TECHNICAL EDUCATION

Science education (SE) is the foundation of technical education (TE) worldwide. There is a close relationship between SE and TE as reflected in the definition of Okolocha (2012), in that TE is the study of technologies and related sciences. No student can be successful in technical education without a sound knowledge of Physics and Chemistry.

There are many concepts and topics students learned in science education that are crucial to technical education. The foundations of these topics start in science education, and the application is germane to skills acquisition in technical education. For instance, the moment of inertia is a topic that is essential for students who study woodwork, metalwork, and building engineering. An adequate understanding of the topic would help students in technical education and also enable them to apply it in real-life situations. Other issues like young modulus, stress, strain, and shear are also science education topics which have a direct relationship to technical education. Other relevant topics are resistor color coding, integrated circuitry, solid state devices, thermal conductivity, molecular theory, etc. The learning of these topics is apparent in science education, and is more applied in technical education. For example, it is considered unthinkable for a graduate of electrical electronics to be seeking a paid job if s/he had received a genuine authentic learning experience. The same applies to graduates of building technology, woodwork, and metalwork.

Therefore, the inclusion of technologies in education will enhance skills required in the Nigerian labor market that demand authentic learning in science and technical education.

The aforementioned nine authentic learning elements that could be applied to learning as a strong foundation for STE in Nigeria are discussed in detail in the following sections of this paper.

AUTHENTIC LEARNING ELEMENTS

Authentic Contexts

This is a situation that reflects the way that knowledge is used in real-life. Authentic learning environments ensure learners have personal control over what they learn and how it is learned. (Watters & Ginns, 2000). Herrington and Kelvin (2007) argued that authentic contexts in the classroom are not just simple examples from real-world practice that illustrate a concept to be taught. The authors concurred that authentic contexts must be all-embracing in order to provide the purpose and motivation for learning and complex learning environment that can be fully explored. The authentic learning environment must be a physical environment that mirrors the way that knowledge will be used in real-life (Brown, Collins, & Duguid, 1989).

Authentic Activities

Authentic activities or tasks show different activities that people contend with in the real world over a sustained period instead of short unconnected examples (Herrington & Kelvin, 2007). According to Herrington (1997), any authentic task should have the characteristics of promoting exploration where students can solve problems; give

opportunity to detect relevant and irrelevant material; and allow for sustained thinking by exploring topics in-depth. Authentic activities should match real-world tasks of professionals in practice as near as possible (Lombardi & Oblinger, 2007). Authentic activities should be comprised of complex tasks that are investigated by students over a sustained period (Herrington, Oliver, & Reeves, 2003). Rule (2006) posits authentic activity as a component of authentic learning that is targeted towards real problems, and that has a potential impact outside of the classroom.

Expert Performances

Expert performances and the modeling of processes afford students the opportunities to watch tasks being performed before attempting it themselves (Herrington, 1997). Through watching the experts, students have the opportunity of comparing their own performance, skills and understanding with that of an expert in the field (Collins, Brown, & Holum, 1991). Authentic learning environments give students the opportunity to observe an expert's thinking and performance, allowing students to observe a task before attempting it and to access the modeling of processes (Herrington & Kelvin, 2007). The expert's idea could be in the form of video movies of an expert in their professional field, or the opportunity for sharing narratives and stories (Brown et al., 1989). This idea is drawn from the apprenticeship system, where a learner is assigned to work alongside an experienced practitioner (Herrington, 1997).

Multiple Roles and Perspectives

Instead of learning through interaction with a single perspective such as a teacher, an authentic learning environment provides the learner with the opportunity to investigate multiple ideas, roles and perspectives (Herrington & Kelvin, 2007). Honebein (1993) defined multiple perspectives as a significant cognitive activity that should be promoted in the design of authentic learning environments. It allows different perspectives from different points of view; not just a single perspective such as a textbook (Herrington et al., 2010). Multiple roles and perspectives allow different people, media and resources to be employed as required in order to provide a rich array of opinions and points of view (Herrington & Kelvin, 2007).

Collaborative Construction of Knowledge

To ensure students learn in a way that will reflect the real-life situation, there is the need for collaborative learning. Herrington (1997) pointed out that collaboration and the opportunity to collaboratively construct knowledge is an essential element of authentic learning. Collaboration is not just ordinarily placing students in groups during learning. Collaboration is not about working together in a group, but solving a problem together. Herrington et al. (2010) contended that the characteristics of good collaboration are: working in teams or pairs, not individuals; task-focused groups rather than individual; and, encouragement through the application of technology.

Katz and Lesgold (1993) succinctly argued that collaboration is more than cooperation because whereas collaboration is synchronous, cooperation may be either synchronous or asynchronous, or both. "Collaboration allows students to 'put their heads together' on problems, and to fully articulate their progress as they go about the task" (Herrington & Kelvin, 2007, p. xx).

Reflection

Reflection is intellectual and practical activities in which someone participates in order to utilize their experiences leading to new knowledge (Boud, Keogh, & Walker, 1985). Reflection has three features which are; returning to the experience, attending to feelings, and reevaluating the experience. Herrington and Kelvin (2007) believed that there is loss of learning opportunities in school where students are not allowed to reflect upon and consolidate their learning. To think about their learning, students should frequently return to the experience, recollecting the important considerations and relating them to their partners (Herrington & Oliver, 2000). Reflection is an opportunity to think about, reflect upon, and discuss choices. There are reflections "in" and "on" learning. "Reflection in learning" is when choices are made during the learning, while "reflection on learning" is choices made after the learning (Herrington et al., 2010).

Articulation

The process of articulation allows for the formation, awareness, development, and honing of ideas (Herrington, 1997). The students' opportunity to verbalize their thoughts in pairs allows them to be aware of their learning and to make appropriate links to incorporate it into their cognitive framework (Herrington & Oliver, 2000). Articulation provides students with an opportunity to speak and write about their growing understanding (Herrington et al., 2010).

Research studies have shown that students should be able to defend their view in science through a logical argument as part of their learning. Kuhn (2009) contended that the skills of argument are fundamental intellectual skills, and worthy of attention in science education. As an important aspect of scientific inquiry, argumentation plays a role in the generation and justification of knowledge claims (Erduran, Ardac, & Yakmaci-Guzel, 2006). According to Kuhn and Reiser (2005), argumentation or persuasion has been observed to enhance student participation in the learning process and therefore engagement with the content under consideration. Articulation enables the student to be able to make a public presentation to defend their position and ideas (Herrington et al., 2010).

Coaching and Scaffolding

Scaffolding is a process in which students are given support until they can apply new skills and strategies independently (Rosenshine & Meister, 1992). An authentic learning environment enables coaching at crucial times, and scaffolding of support, where the teacher provides the skills, methods, and connections that the students are unable to provide themselves prior to the end of the activity (Herrington, 1997). Scaffolding also has benefits to student learning such as scaffolding instruction providing a supportive learning environment (Johnston & Cooper, 1997). The authors stated that a scaffolding learning environment provides students with the opportunity to ask questions, receive feedback and support their peers in the learning of new material. Scaffolding as a principle of effective instruction provides teachers with the opportunity to accommodate individual student needs (Kame'enui, Carnine, Dixon, Simmons, & Coyne, 2002).

Authentic Assessment

Authentic assessment is when the assessment is integrated with the task instead of testing separately (Herrington et al., 2010), and implies seamless integration of both assessment and the task. Young (1993) contended that assessment must become an

integrated, on-going, and seamless part of the learning environment. Gardner (1992) argued that formal tests and assessment materials are not adequately sensitive to account for cultural differences, and that they are rarely used in determining students' level of competence.

AUTHENTIC LEARNING IN SCIENCE EDUCATION

Memorization characterizes the teaching and learning in Nigerian schools, and this results in low retention of learning (Aina, 2017b). For teaching and learning to be authentic and for students to be able to practice what they learn in new situations requires that some or all of the nine elements of authentic learning should be applied where practicable.

The science classroom should not only use textbooks and notes from the teachers, but should instead use learning materials that make learning resemble practice in real-life situations. Students should have control over what and how they learn. They should be allowed to search for information by themselves. Students should be critical thinkers who identify premise and are able to draw logical conclusions. According to Herr (2007), critical thinkers break arguments into basic statements and draw their own logical conclusions.

Learning activities or tasks should reflect the kinds of activities that people do in the real world. The tasks must not be too well-defined, and therefore promotes exploration where students find as well as solve problems. The learning situation where the learning task for students is in a well-defined step-by-step procedure does not help learning, but only aids memorization. For a teacher to make learning contexts and activities resemble real life, in most cases it requires the use of technology. Thus, the students become familiar with the application of technologies as against the conventional method of teaching with textbooks and listening to teacher's lecturing.

Learning tasks must be such that they encourage collaboration between students, and between the teacher and students. Students should be allowed to collaborate and not only cooperate. As previously discussed, collaboration is an essential element of authentic learning and critical to scientific inquiry. Collaboration promotes dialogical argumentation which is crucial to modern science learning. Sampson, Enderle, and Grooms (2013) argued that teachers need to provide students with more opportunities to craft scientific arguments and participate in discussions that require them to support and challenge claims based on evidence. A genuine collaboration for learning requires students to go online to seek information in order to refute some proposition during an argument. Authentic learning does not support the acceptance of information without thorough investigation or proof.

It is an essential part of authentic learning for the teacher not to consider themself as the sole authority in the class, but as being there to coach and scaffold. The teacher should also act as a learner, but guide the students where needed and withdraw to enable the students to learn by themselves. It is not about covering the syllabus, but allowing the students to reflect both in and on what they have learned. This implies that students should be able to revisit the learning tasks at any time. There should be opportunities for students to articulate their understanding. Articulation enables students to verbalize what they learned either in a collaborative group or through presentation to the class. Reflection means both the students and the teachers should be able to retrieve the learning information at a later time. Retrieving information is best done with the help of the available technologies.

Students must learn through various resources. Science learning should not only be through the textbooks and teachers. The inclusion of technologies in learning makes it easier and more authentic. Different mobile technologies promote authentic learning that is readily available in the science class. Through these, students can access different databases apart from the typical Google search engine. The community learning paradigm is in vogue in many developed countries which utilize learning authentic. For instance, field trips and expert performances are germane to science and technical education in authentic learning. It should form part of a learning task to bring professional experts to the classroom so that students can learn from them. Otherwise, video movies of such experts could be shown to the class to learn from and then to ask questions to the teacher.

Assessment is essential in science and technical education, but it must be made authentic. Assessment should not be a onetime test as done in many schools. It ought to be scheduled along with the learning tasks. It is not mandatory to be a graded assessment. This could be the teacher observing the students as they collaborate in learning or as they articulate their understanding.

Given the authentic learning in science and technical education as discussed, the students will not rely on simple memorization, but learn to "do" STE. Authentic learning in science and technical education where students learn and can apply the knowledge outside of the classroom is crucial to STE. This cohort of students would then have the technical skills to utilize anywhere in life. Most of these students would therefore be able to access email, Skype, blogs, search databases, and can successfully use Microsoft PowerPoint and Excel spreadsheets, and other computer applications for learning.

Conclusion

To achieve quality STE that matches the technological needs of the Nigerian labor market requires authentic learning in science and technical education. The industrialization and technological growth of Nigeria is significantly low due to the inability to adequately use scientific ideas to promote technology (Ojimba, 2012). Therefore, the need to harmonize science and technical education through authentic learning is imperative. Hence, practical knowledge of science and technical education through authentic learning is the springboard upon which quality technologies in education stand. As a final note, this paper believes that the technical education could be a panacea to the unemployment challenges seen in today's Nigeria (Olajide, 2015), but only if authentic learning in STE is permitted and encouraged within the Nigerian educational system.

This paper has implications for Nigeria as a nation. Research studies indicate that the pedagogical approach to teaching is the bane of active learning in the country (Riveros, 2012; Wanbugu, Changeiywo, & Ndiritu, 2013). It thus implies, for the success of authentic learning in science and technical education to serve as a strong foundation for technologies in education, there should be a paradigm shift in teaching strategies to research-based pedagogies (Aina & Langenhoven, 2015).

It is essential for both teachers and students to understand that science and technical education includes students of different learning styles. Therefore, proper application of the theory of multiple intelligences by the teacher is germane (Aina, 2018). It is also essential to understand that most of the students that receive good grades in their courses cannot actually go on to deliver in the workplace because of the insignificance attached to the role

of social learning. Authentic learning thrives where both teachers and students value social learning. The conventional methods of teaching utilized in Nigerian schools today do not appreciate social learning. Teachers deliver their lectures and leave the class with little or no consideration for social interaction in the class. The importance of social interaction is critical to students' learning beyond the classroom, as supported by the theory of social constructivism.

Students are expected to be active from the start of the teaching to the end. The pedagogy adopted must have zero tolerance for students' inactiveness in the classroom. There is a need for "intellectual controversy" that will spur students to collaboratively dialog during the learning period. Research studies shows that learning of this type has a high retention and is retrievable in life, which is the tenet of constructive controversy theory.

The paper has a security implication for Nigeria at this crucial period of national insecurity. Insecurity is rife in today's Nigeria due to insurgency in the North, the Middle Belt and in some parts of the South. There are cases of armed robbery and kidnapping everywhere attributed to youth unemployment and lack of practical education. Many of these insurgents, robbers, and kidnappers are youths who probably lacked a practical education. If these youth had been appropriately trained through authentic learning, they would have more likely been skillful in technologies in a way that could engage them in meaningful jobs rather than a life of crime. Therefore, this implies that authentic learning could be part of the solution to the national security challenges faced in Nigeria today.

Given this, some suggested research-based pedagogies that support authentic learning are Peer Instruction (PI) (Al-Hebaishi, 2017; Ouko, Aurah, & Amadalo, 2015), Peer Instruction Argumentative Strategy (PIAS) (Aina, 2017a), and Brain-Based Learning (Kaufman et al., 2008). Both PI and PIAS enables students to learn with peers or in groups in order to collaboratively solve problems through dialogical argumentation. Brain-based learning requires a conducive learning environment for the brain where there is no threat to learning, but plenty of challenges.

Notes

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