



Digital Integration Into Science And Mathematics Teaching: The Need For A Paradigm Shift To Peer Instruction (PI) In Nigerian Schools

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ABSTRACT

In the last decade, there have been conscious attempts by nations to integrate digital tools into their educational system especially at the tertiary level. Nigeria is no exception. The policymakers in the country at the federal and state levels have felt the need to integrate Information Communication Technology (ICT) in their educational policies. It is felt that in this globalized world the country must embrace digital technology to enhance support teaching and learning environment. It is the belief that in the present globalized world every nation should embrace digital technology to be competitive and also to have a knowledge-based society as well as information society. The COVID-19 pandemic has also made it imperative that countries should advance towards e-learning. The future of education is therefore intertwined with Information Communication Technologies (ICTs). The Nigerian government have realized that the new normal or post-COVID-19 pandemic environment has made the traditional method of teaching and learning outmoded. Nigerian schooling system is divided into three levels. Students' academic performance in science at both the secondary and tertiary levels of this schooling system has been poor due to many factors. One of these factors is teacher's strategy of teaching. That is why this paper is advocating for a shift in the pedagogy of teaching in science education. Based on the weaknesses of the lecture and other teaching pedagogy in science, the paper considered digital integration and Peer Instruction (PI) to be better alternatives. It is therefore in this regard that most policymakers in Nigeria are advocating an advance towards ICT and other novel instructional strategies hence there is what we can call paradigm-shift in terms of teaching and learning of science in Nigerian schools Recommendations have been proffered.

Keywords: Digitalization, Education, E-learning, Globalization, Peer Instruction

INTRODUCTION

In recent years every nation has realized that Information Communication Technologies (ICTs) are important in all spheres of life of the society. Information Communication Technologies (ICTs) have become the most important factor in the rapid development of any society. History, it is asserted, has proved this in terms of countries that have developed rapidly because of their technical skills in ICTs. Globalization has been made possible by Information Communication Technologies (ICTs) which has triggered in an unparalleled way the shrinking of space and time in the world today. Modernity has become associated with information technology. Globalization has been defined in various ways but

Giddens (1990) is probably the most appropriate definition which captures the process of globalization. He conceives the process of globalization as the interdependence of world societies in such a way that technology is the most singular factor that has propelled this process of globalization. This conception of globalization is also expressed by Hosen, (2020; Ivanov, 2020; Jameson, 2015; Appadurai, 2005; Lyotard, 1979; Conley, 1977).

In each nation of the world today there is an awareness and appreciation of technologies as the most important factor for the advancement of society. ICT has made the world highly dependent on knowledge produced by it in terms of information that can be accessed for socioeconomic and political development. It is because of this that modern society has been characterized as a knowledge-based society. Some scholars have characterized this society as digital or information society which is an attempt to link it up with technology (Atoy, et al. 2020; Ayodele, 2020; Waheed, et. al.; García-Peñalvo et. al. 2017). These two concepts give us the idea that modern age is based on the accumulation of information which has a spinoff on society in terms of socioeconomic and political development. Hernandez, (2017) defines knowledge-based society as the social transformation occurring in modern society and its impact on various areas of human endeavors.

In another twist to the two concepts, Andalia (nd. cited in Hernandez) notes that there is a difference between knowledge-based society and the information society. He claims that information society is designated through information and communication technologies while knowledge-based society is anchored on a conception that conveys and stimulates its resources through the application of technological tools. The two concepts demonstrate that their origins and development stem from technological innovations and advances that are closely related to information communication technology. It is pertinent to note that technological innovation and advancement have been largely fostered or brought about in the field of education. Education has been the main agent of change in societies through technologies in the 21st century. It is in this regard that societies now give premium to information technologies in their educational system. Most societies especially developed ones are conscious that technological innovations are important for society and hence they have a robust educational policy in the management of information technologies (Hernandez, 2017).

Some developing countries like Nigeria have also become conscious of information technologies as an important factor in the transformation of society and have fashioned out a pragmatic educational policy in managing information communication technology in their educational system. It has been observed that there is a symbiotic relationship as earlier pointed out between technology and social transformation. It is in this sense that the connection between technology and knowledge has been seen as playing an essential role in societal development and transformation (Alaimo et. al., 2020; Valderrama, 2012). This connection between technology and education has implications for socio-economic development. In knowledge-based society the impact of ICT is enormous. In terms of form and content, the changes wrought by ICT have had a multiplying effect to such an extent that the wider society has been permeated by the idea of ICT being the propeller of changes in socioeconomic and political domains especially in developing countries like Nigeria.

Integration of Information Communication Technology (ICT) into the Nigerian Educational System

The integration of ICT into the educational system has gone beyond the technological tools which are used in the teaching of students. It has made the learning process to go beyond the traditional teaching method. The technological tools have helped in imparting knowledge much better than the old methods. The Nigerian national implementation guidelines for ICT in education define Information Communication Technology (ICT) as “the art and applied sciences that deal with data and information. It encompasses all (equipment including computational machinery – computers, hardware, software, firmware, etc., tools methods, practices, processes, procedures, concepts, principles, and the sciences) that come into play in the conduct of the information activities: acquisition, representation, processing, presentation, security, interchange, transfer, management, organization, storage, and retrieval of data and information” (NIGICTIE, 2019). These tools started with the emergence of calculators, voice recorders, television sets, etc. But there are many more advanced tools now - computer, World Wide Web (www). Wang, 2020 defined “web as a series of interconnected documents stored on computer site or websites.” The use of the internet facilitates e-learning within the educational system.

The internet relay chat includes some components that is been used to communicate globally such as Zoom, Skype, Google Meet, and Microsoft Team. Some other internet tools which allow people to exchange ideas with each other through the internet are eportfolios, cyber infrastructures, digital libraries, and online learning object repositories, etc. There are also e-modules which are written and could be converted and stored into a digital version and transferred into a computer using word processor accessible by the user through the internet. All these technologies are tools that are deployed now in education (Ureigho et al. 2015). They are also used in teleconferencing – audio conferencing involves a live exchange of voice messages over a telephone network and still images such as graphs, diagrams, or pictures. There is also video conferencing which makes it possible for showing moving images as well as voice and graphs. Video conferencing technology does not use telephone lines but either satellite link or telephone network. The next one is web-based conferencing and it is as the name implies the transmission of text and graphic, audio and visual media through the internet. It requires the use of a computer attached to a browser and communication can both be synchronous and asynchronous.

All these technologies play a greater role in education by improving the quality of education. With the COVID-19 pandemic which is ravaging the world now, it is impossible to have the traditional face to face conference hence institutions have resulted in teleconferencing. Zoom is mostly deployed now. Zoom is a web-based video conferencing tool with a local, desktop client and a mobile app that allows users to meet online and collaborate with or without video. Zoom users can choose to record sessions, collaborate on projects, and share or annotate on one another's screens, all with one easy-to-use platform. Education is now regarded as the fulcrum of social change. In this regard societies all over the world lay much emphasis on the education of their citizens. They invest heavily in the education of their citizens. Education aids any nation in terms of its economy, social and political upliftment. It is therefore imperative for any nation that wants to develop to fashion its educational policies towards the development of its citizens as well as bringing about changes in all areas of human endeavors. It is also through education that knowledge is imparted which involves skills that can be used for the development of society. According to UNESCO, (2000), "Education refers to the total process of developing human ability and behaviours." It is an organized and sustained instruction in terms of learning designed or fashioned to communicate a combination of knowledge, skills, and understanding value for all activities of life. Education molds total humankind to solve his problems in life. It is also a tool through which they come to understand their environment and if necessary, change their environment for the better of their environment in the world. Fafunwa (2018) notes that education is "the aggregate of all the processes by which the learner develops abilities, attitudes and other forms of behaviors which are of positive value to the society in which he/she lives." He further claims that education is also a process of transmitting culture which allows for its perpetuity in space and time. Education also, according to Fafunwa, disseminates knowledge in other to ensure social control as well as guarantee rational control of society. Education could also be seen as a systematic procedure for the transfer and transformation of culture through both formal and informal methods of training people in society. It deals with the mental, physical, psychological, and social development of citizens. Education is also conceived as an institution that makes individuals think freely and rationally which enables social progress and innovations to be possible (Kurilovas, 2020). Social progress and innovation are the key ingredients of how society has fared better in terms of its advancement to a higher stage of development. When progress occurs in any society its members can think freely and rationally and can, therefore, innovate which could impact society.

From the above therefore it can be seen that education is a tool for social change. Given the importance of digital technologies most countries have fashioned out a robust educational policy in their educational system hence they have to prioritize digital technologies. Nigeria is not an exception to this. It is realized by stakeholders or educational policymakers those digital technologies must be incorporated fully into the educational system. This is reflected in the policy on ICT by the federal government of Nigeria in their 9- 3- 4 educational policy which is entitled National Implementation Guidelines for ICT in Education henceforth called (NIGICTIE, 2019). It has vision and mission. The vision is "to make education universally accessible, empowering, inclusive and enriching". And the mission is "to meet the human capital investment of the nation for attaining and enhancing sustainable socio-economic development, global competitiveness as well as the individual's ability to survive in a contemporary environment" (NIGICTIE, 2019).

The objectives of ICT in education are spelled out in the educational policy on ICT.

These are:

- To facilitate the teaching and learning processes.
- To promote problem-solving, critical thinking, and innovative skills.
- To promote life-long learning and advance knowledge.
- To enhance the various teaching/learning strategies required to meet the needs of the population.
- To foster research and development.
- To support effective and efficient education administration.
- To enhance universal access to information.
- To widen access to education and the range of instructional options and opportunities for any-where, any-time, any-pace and any-path learning.
- To promote the commercialization of ICT in education.
- To develop and support technical infrastructure that maximizes digital creativity, sharing, and innovation.

The Nigerian school system is divided into Primary, Secondary, and Tertiary school. Pupil spends six years in primary before they move to a secondary school where they also spend six years. The six years of secondary schools are divided into three years of Junior Secondary School (JSS) and three years of Senior Secondary School (SSS). The last level of the educational system is tertiary school level. These are the University, Polytechnics and the College of Education. Number of years spent in these institutions depends on the type of course. However, for the science education, irrespective of the kind of the institution, the maximum year allowed is 5years. Science education is not clearly defined in primary school in Nigeria, except for the study of basic science technology. In the secondary schools, there is basic science at the JSS level. At the senior secondary School (SSS) level, there is biology, chemistry and physics taught separately. At a tertiary level, the main focus of this paper, science education is clearly defined to be biology, chemistry, and physics studied together with the principle and method of education. Many teachers handling the science subjects in most of our secondary schools specializes in science, not in science education (Omosewo, 2009).

Therefore, these teachers lacked appropriate instructional strategies for teaching and often used lecture method. Science education in Nigerian schools is faced with many challenges, one of such challenges is the out-of-field teaching. This is when a teacher is assigned to teach subjects for which he or she has not got adequate training and qualification (Ingersoll, 2002). These categories of teachers need a change of teaching method as most of them teaches by the lecture- based instruction. This lecture method has been criticized for lack of effective interactive approach and caused poor academic performance in science education. The performance of students in science subjects in the resent time has not been very good (Erinosho, 2013; Crouch, Watkins, Fagen and Mazur, 2007). The concern for every Nigerian is what the causes of this poor performance are. Among the causes of this poor performance is the teachers' method of teaching (Wanbugu, Changeiywo and Ndritu, 2013); Oladejo, Olosunde, Ojebisi and Isola, 2011). Based on this, it is important to review the different type of teaching methods in science education, their disadvantages and the need for a shift of paradigm.

Teaching methods in Science Education

There are different teaching methods employed in science education in Nigerian tertiary institutions. Miles (2015) asserted that it is expected of a teacher to implement a range of instructional strategies that will bring academic success to all the science students. For any method to be able to bring good result in the present age, it should be a method that promote maximum social interaction. Social interaction between students and between teacher and student plays a crucial role in learning (Nguyen, Williams, and Nguyen, 2012). These authors further stressed the need for the students to be provided with a supportive, open and interactive environment as this could help them discover knowledge. The teaching methods commonly used in science education classes are lecture and demonstration method.

Lecture method

Is often used to deliver a large amount of information to the students in a short period (Berry, 2008). According to Gehlen-Baum and Weinberger (2014), lectures are designed to deliver a new information to a large group of students. This method is known to be effective in dealing with a large class. However, it could also be used for a small class. Research indicates that this method dominates

most of the tertiary institutions (Deslauriers, Schelew and Wieman, 2011). Research shows that students' retention in a lecture-based science courses is weak. According to Bok (2006), an average student only retains 42% of what he or she learned after the end of the lecture and 20% one week later. Research shows that teaching method like the lecture method commonly used does not help the students to acquire sufficient functional understanding (Bernhard et al., 2007). Berry (2008) argued that lecture method lacks the effectiveness of an active learning approach. In the opinion of Fagen and Mazur (2003), lecture method causes the bad reading habit among the students. Franklin, Sayre, and Clark (2014), students taught in lecture-based classes learn less than those taught with activitybased reformed methods. Lecture method is frequently a one – way process unaccompanied by discussion, questioning or immediate practice that makes it a poor teaching method (Hatim, 2001; Al-Rawi, 2013). Lecture method concentrates on information rather than learners (Al-Rawi, 2013). In the lecture method the teacher tells the students what to do instead of activating them to discover for themselves (Miles, 2015).

Demonstration teaching method

This is a useful method of teaching because it improves students' understanding and retention (McKee, Williamson, and Ruebush, 2007). According to AlRawi, 2013), the demonstration is effective in teaching skills of using tools and laboratory experiment in science. However, the time available to perform this demonstration is very limited in a classroom setting. Therefore, a demonstration often designed to allow students to make observations rather than through hands-on laboratory (McKee, Williamson, and Ruebush, 2007).

Theoretical Model

The underpinning theories in this paper are that of constructivism and Constructive controversy theory. The constructivism theory emphasizes that learning should be an active process in which learners construct new ideas or concepts based upon their current or past knowledge (Brandon and All, 2010). The constructive theory model sees constructivism as a spiral with the students at the center of the spiral making students the center point of learning.

The constructive controversy involves deliberative discussions aimed at creative problem solving (Johnson, Johnson, and Tjosvold, 2006). Students must be skilled collaborators, and follow the norms of cooperation and the rules of rational argumentation. Students are strongly motivated to produce solutions, and display high-level reasoning and greater mastery and retention of new knowledge gained. They generate high quality and creative solutions.

The constructive controversy exists when one person's idea, conclusions, and opinions are not compatible with another person's ideas, conclusion, and opinion, but the two seek to reach a consensus on the solution to the problem or the course of action to take in a situation (Johnson and Johnson, 2003). Constructive controversy is not a debate nor is it an individualistic approach to a controversial issue. It is a procedure for cooperative learning where individuals with different, incompatible views agreed on a position based on evidence and reasoning (Johnson and Johnson, 2007).

The thrust of this paper, therefore, are changing of teaching paradigm to PI and digital integration because they are both interactive pedagogies. They engage students during class through activities and cooperative learning technique (Rao and DiCarlo, 2000; Lombardi and Oblinger, 2007). Teaching method like PI makes the students active in the class and aid students' high retention, but retention is low where students are passive.

Peer Instruction

Peer Instruction (PI) is a research-based pedagogy for teaching large introductory science courses (Fagen and Mazur, 2003). It is a method created to help make lectures more interactive and to get students intellectually engaged with what is going on. It has been tested in many classes and found to be good for improving students' performance and also used to identify student difficult areas. PI has been used in different subjects in many countries. Peer Instruction is still a new method of teaching for teachers in many countries because of its unique feature of Concept Test. Peer Instruction is an instructional strategy for engaging students during class through a structured questioning process that involves every student (Crouch, Watkins, Fagen and Mazur, 2007). PI provide a structured

environment for students to voice their idea and resolve misunderstanding by talking with their peer (Gok, 2012).

Peer instruction is a cooperative learning technique that promotes critical thinking, problem solving, and decision-making skills (Rao and DiCarlo, 2000). Research shows talking to peers forced them to organize their thoughts and reminded them of the concepts they had difficulty recalling on their own (Gok, 2012). Peer Instruction is an interactive approach that was designed to improve the learning process (Rosenberg, Lorenzo and Mazur, 2006). This method has the advantage of engaging the student and making the lecture more interesting to the student. It also has the tremendous importance of giving the lecturers significant feedback about where the class is and what it knows. PI is more effective at developing students' conceptual understanding than traditional lecture-based instruction (Lasry, Mazur and Watkins, 2008).

According to Crouch, Watkins, Fagen and Mazur (2007), PI increases student mastery of both conceptual reasoning and quantitative problem solving. PI increase conceptual learning and traditional problem-solving skills (Lasry, Mazur and Watkins, 2008). According to (Gok, 2012). PI encourages students to take responsibility for their learning and emphasize understanding. Peer instruction increases student conceptual learning and performance on quantitative problem-solving questions. PI is not a rejection of the lecture format, but a supplement that can help engage students who have a range of learning styles (Rosenberg, Lorenzo and Mazur, 2006). Peer Instruction involve students during class through activities that require each student to apply the core concepts being presented, and then to explain those concepts to their fellow students. Unlike the common practice of asking informal questions during a traditional lecture, which typically engages only a few highly motivated students. PI incorporates a more structured questioning process that involves every student in the class. The goal of PI is to transform the lecture environment so that it actively engages students and focuses their attention on underlying concepts. Instead of teaching from the textbook or lecture notes, lectures consist of short presentations on the main points. Each followed by short conceptual questions called Concept Test, typically posed in a multiple-choice format, on the subject being discussed.

With using PI, the instructor starts with a brief presentation or summary of the material to be covered. After this, the instructor poses a Concept Test and asks students to think about the question and related concepts. The instructor then allows 1–2 minutes for students to think and come up with an individual answer. This may be through clickers, flashcards, a simple raising of hands, or writing down the answer on a piece of paper. The instructor may revisit the concepts using lecture or try a different Concept Test if too few students' responses to the answer are not correct. If a majority of students' responses is correct, the instructor will then give a brief explanation and moves on to the next topic or Concept Test. In a situation where 30–70% of the students answer the concepts correctly, the instructor asks students to turn to their neighbours and discuss their answers. Students talk in pairs or small groups and are encouraged to find someone with a different answer. The teacher moves around the room to encourage productive discussions and guide student thinking. After several minutes, students re-examine the same concepts and the instructor then explains the correct answer.

CONCLUSION

The present state of the world with the COVID-19 pandemic it becomes imperative that traditional mode of education will have to be abandoned for a new mode of learning which involves the introduction of digital technologies into the educational system in all ramifications. Nigeria has to embrace the new normal in terms of post-COVID-19. This new normal has made certain learning imperative which is different from the way learning was conducted in the past. In other words, there is a kind of paradigm shift in terms of teaching/learning which involves digitalization and Peer Instruction. It is in this respect that Nigeria has to embrace this new form of teaching/learning in its educational system and because of this, it must gear up the digitalization of its educational system Based on the above discussions, it is obvious that there are already known teaching pedagogies in science that actively engages students in the class. However, PI could be a better one based on various reviewed studies that PI is a teaching pedagogy that engages students in active learning through the use of Concept Test

RECOMMENDATIONS

The Nigerian guideline policy on ICT is comprehensive in scope and with this new reality, it must be updated to match the present situation in terms of the pandemic. Nigeria has to deploy digital technologies and PI in its educational system so that it will meet up with the competitive globalized world. The various literature reviewed confirmed the effectiveness of Peer Instruction and digital technologies in improving conceptual and problem-solving skill of the students. Therefore, it is suggested that more research studies using PI in Nigerian schools at all levels should be carried out in science education to ascertain the veracity of its effectiveness. It is also important to carry out studies using Peer Instruction to teach other subjects in both primary and secondary schools in Nigeria.

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