International Journal of Advanced Studies in Ecology, Development and Sustainability
Vol. 3, No. 1 January, 2015 ISSN HARD PRINT: 2354-4252 ONLINE: 2354-4260
© www.internationaljournal/Journals/advanced-ecology-dev-sustainability-vol,4No.1
ASEDS: 015:2:4

EMBARKING ON IMPROVISATION IN CURRENT ELECTRICITY FOR EXPOSURE OF PHYSICS STUDENTS TO DIGITALIZATION FOR SUSTAINABLE DEVELOPMENT

[1]Nwosu, Frederick Chukwuebuka [2]Odigwe, Fidelis Obi &
[3]Nwoye, Amarachukwu Nkechi
[1&2]Department of Electrical/Electronic Engineering
Federal Polytechnic Oko, Nigeria
[3]Department of Science Education Nnamdi Azikiwe
University Awka, Nigeria

Abstract
Nigeria as a developing nation should match towards education activities that will bring sustainable development of the nation, especially in this era of computer and information technology (IT). Involvement in education activity like improvisation in current electricity can bring about exposure in digitalization associated with computer and information technology. The thrust of the paper is embarking on improvisation in current electricity for physics students' exposure to digitalization necessary for sustainable development. The paper pointed out that instructional materials are needed for effective education in current electricity (a part of physics) necessary for acquisition of knowledge and skill in digitalization. When the instructional materials are lacking, there is need to embark on improvisation so as to achieve sustainable development. Issues discussed in the paper are: relevance of digitalization in sustainable development; current electricity as a basis for digitalization; need for improvisation in current electricity; and improvisation in current electricity for exposing physics students to digitalization.

Keywords: sustainable development, digitalization, improvisation, instructional materials, current electricity, physics.

Background to the Study
Nations of the world are striving for sustainable national development. Sustainable development is fostering the well being of people such that it does not disappear after a certain period of time rather the wellbeing is continuous so as to be favourable to both the present and future generation. In the same view, World Commission on Environment and Development (1987) asserted that sustainable development is the development that meets the need of the present generation without compromising the ability of future generations to meet their own needs. Onwudinjo

(2010) pointed out that sustainable development deals with: maintenance of high and stable levels of growth and development, social progress which recognizes the needs of every one, effective protection of the environment, and prudent use of natural resources.

Nigeria as a developing nation should match towards sustainable development by having strong focus on science education; and physics is among the science education. Physics is a science which deals with the relationship and interaction between matter and energy. One of the branches in the study of physics is current electricity. The study and utilization of current electricity is the basis for digitalization which has given strength to emergence and use of computer and information technology in this modern society (21st century). It can be deduced that for adequate exposure of physics student to digitalization for sustainable development there should be effective study in current electricity. Studies and operations in current electricity have lead to the production of electrical devices and systems useful for socio-economic wellbeing of human society and, hence, sustainable development. Okeke and Anyakoha (1989) asserted that the study of electricity is an important subject in physics because the working of most modern appliances such as radio, television, computers and calculators, refrigerators, air-conditioners, sound systems and electric fans is possible as a result of electricity. Ezeilo, Chukwulobe, and Jaja (2013) pointed out that the presence of electricity brought about electronic technology; and examples of product of electronic technology that are usually encountered are computer, video machines, audio amplifier, television, radio, phone set, calculator, etc.

Effective study cannot take place in physics and, hence, current electricity without the use of instructional materials. Usually, the instructional materials needed for teaching physics, which includes current electricity, are mostly laboratory equipment. Unfortunately, Nigeria, as a developing nation, has a lot of schools in the nation faced with the problem of unavailability or poor (inadequate) supply of laboratory equipment (Achor, Taangahar and Musa, 2011). When there is lack of standard equipment in a physics laboratory, there is need for improvisation. Improvisation is the use of alternative materials, especially locally made ones, to substitute the standard (conventional) instructional materials. Improvisation of instructional material needed for teaching current electricity is essential so as to expose physics students to digitalization useful for sustainable development.

Objective of the Study

The objective of the paper is to point out that instructional materials are needed for effective education in current electricity (a part of physics) necessary for acquisition of knowledge and skill in digitalization.

Literature Review

Digitalization is concerned with production and utilization of quantities and circuits that operate in digital form (ie discrete manner). It is mostly associated with electronics. Generally, electronics is the study, design and use of devices based on the conduction of electricity in a vacuum, a gas or a semi-conductor but modern electronics is principally concerned with semi-conductor. Digitalization can be viewed as use of digital electronics, which is an aspect of electronics, in building of digital systems. A digital system is a combination of devices or circuits for manipulation of physical quantities or information in a discrete (ie digital) form. Some of the familiar digital systems are calculators, digital watches, digital computers, traffic-signal controllers, typewriters, etc. (Gupta, 2008).

Digitalization has brought a shift from analogue techniques to digital techniques (analogue quantities usually vary over a continuous range of values). Usually, digital system has certain advantages over analogue systems. Tocci, Widmer and Moss (2007) pointed out that advantages of digital techniques that are chief reasons for the shift from analogue to digital technology are:

1 Digital systems are generally easier to design
2 Information storage is easy
3 Accuracy and precision are easier to maintain throughout the system
4 Operation can be programmed
5 Digital circuits are less affected by noise
6 More digital circuitry can be fabricated on integrated circuit (IC) chips.

The advantageous nature of digital systems has led to advancements in electronic technology as can be seen in the use of computer and other systems in information technology (IT). Thus, relevance of digitalization in sustainable development can be understood by discussing the importance of computer and information technology in national development. Computer serves as an essential electronic machine that can make job easier in human society based on its advantageous and important features: it operates at a fast speed and gives accurate result; it has a high memory capacity and so can store huge amount of data and information; it is reliable for it does not experience fatigue and so can perform several functions for a long time; based on the flexibility of computer, data fed into it can be adjusted; and computer does a neat and nice work. In fact, computer operates such as to enhance various activities in human endeavours. Ekemezie (2003) asserted that the purpose of computer system is to speed up problem solving and increase productivity.

Integration of computer technology with communication technology brought about information technology (IT) associated with information and communication. It is axiom that the major purpose of communication is to transmit information. Information enables meaningful

interactions in any human activity; and so information is needed to achieve development. Actually, IT has revolutionized human society into greatness and has brought about the emergence of the Internet that has made the world a global village. With the Internet people can communicate with one another from any part of the world, irrespective of distance and time, for personal and national development using facilities like e-mail, e-learning, e-commerce, e-conferencing, etc.

Importance of digitalization (utilization of digital electronics) can be observed in provision of employment (job opportunity) for income generation. People, especially unemployed youths. can work as an operator of electronic-based system, computer programmer, electronic engineer, electronic engineering lecturer, consultant in electronic-based activities, vendor of electronic products, or manager in electronic-based organization. It is an axiom that jobs provides income for satisfactory living and prevention of idleness that can lead to social vices which jeopardize sustainable national development. The benefits derived from digitalized systems are as a result of researches and studies made with the knowledge of current electricity. In other words, the knowledge of current electricity is a pivot for acquisition of intellectual and technical know-how in digital electronics and systems.

Current Electricity as a Basis for Digitalization

Current electricity is concerned with properties and effects of electrical charges in motion. It is a branch of physics which deals with mobile electric charges in an electric circuit. Electric circuit is a connection of electrical elements such as resistor, capacitor, inductor, diode, transistor, etc to form a path for electric current. Before electric charge can be in motion to consist an electric current, there must be a closed (or complete) circuit having a source of electromotive force for provision of voltage needed in driving (pushing) the electric charge. Current does not flow in an open circuit (incomplete circuit). Electric circuit can operate in a digital or analogue form.

Digital electric circuits are used to build digital systems. Usually, a digital system is a combination of devices designed for manipulating physical quantities or information represented in digital (discrete) values or form. Thus, digital system is often associated with two operational states. The two operational states, which are concepts in current electricity, very much applied in digital system are open-circuit and closed-circuit state, and low voltage and high voltage state. Open-circuit and closed-circuit gives rise to switch action in digital system. Usually, a switch makes a circuit to be "ON" or "OFF". Thus, a switch is a two-state device. Switching in an electrical circuit can be controlled manually, magnetically, thermostatically, or electronically as can be seen in simple manual switch, magnetic relay switch, bimetallic thermostat switch or simple transistor switch respectively (Meadows, 1978).Open-circuit does not bring about flow of electric current; so, it is regarded as OFF state. Closed-circuit allows the movement of electric current; so, it is

regarded as ON state. It is these two states ("ON" and "OFF") that form the basis of digital systems. Thus, it can be said that digital systems are formed by circuits that functions on two states (discrete values). The "ON" and "OFF" state can be represented mathematically (logically) as '1' and '0' respectively. In fact, the open-circuit and closed-circuit gives rise to logic circuits. All digital systems are founded on logic design (Balch, 2003; Tocci, Widmer and Moss, 2007).
A digital circuit can be formed to operate based on two voltage levels – high voltage level and low voltage level. In most digital circuits, a high voltage level can be taken as closed circuit, allowing current flow, and can be assigned logic state of 1; low voltage level can be assigned logic state of 0 and be equated to open circuit which does not allow current flow. On another situation (few cases), a digital circuit can be formed such that high voltage level is assigned logic state of 0, while low voltage level is assigned logic state of 1. Knowledge and skills in digital system ought to be a part of teaching of current electricity to physics students in Nigeria. Effective teaching of current electricity, as a basis for digitalization, to the students may entail the act of improvisation.

Need for Improvisation in Current Electricity

In this modern era, an aspect of physics that plays a great role in advancement of modern technology necessary for sustainable development is current electricity. Thus, there should be great focus on effective teaching and learning on current electricity. For effective education in current electricity, there should be adequate provision and use of instructional materials.

Instructional material promote effective learning because learning become more real to the students in that instructional material has the ability to appeal to more than one sense organ when providing information - learning becomes more real, concrete and immediate when many sense organs are involved in receiving information (Babagbemi, 2006). Ezenwamelaku (1992) in Falomuwa, Nwosu, Nkamuo and Adinu (2013) pointed out that: teaching of physics become abstract when it is taught without apparatus (instructional materials); the teacher will not be motivated in the teaching job and job satisfaction will not be derived. In the case of students, the learning of physics will be uninteresting, boring and non-motivating; and so, at the end, no learning takes place. It can be deduced that physics students taught current electricity without instructional materials are not well exposed to learning experiences which will develop their intellect.

Due to importance of instructional materials in teaching and learning of current electricity, lack of standard equipment (instructional materials) in the laboratory can necessitate improvisation. Improvisation is the use of alternative materials, especially locally made ones, to substitute the standard (conventional) instructional materials. Iwuzor (2000) asserted that improvisation in science teaching deals with utilization of alternative materials and resources to facilitate instruction due to absence or shortage of some specific first-hand teaching aids. Gabriel (1985) in

Ayodele (2000) view improvisation as the act of using materials or equipment obtained from local environment designed either by the teacher or with the help of local personnel to enhance instruction. An incident whereby instructional materials (ie laboratory material resources) needed to teach current electricity to physics students are lacking or in bad state constitutes some problems. So, improvised instructional materials are highly needed for physics students to be well grounded in current electricity. Thus, there is need to embark on improvisation of instructional material for effective education in current electricity. Indeed, in this modern era, a physics teacher should be knowledgeable and skillful in the act of improvisation so as to effectively teach concepts in current electricity for strong orientation of physics students towards digitalization.

Improvisation in Current Electricity for Exposing Physics Students to Digitalization

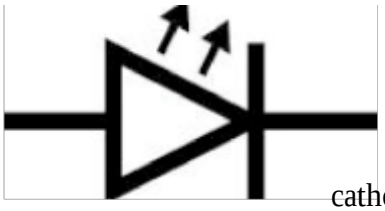
Improvisation of instructional materials in current electricity for exposing physics students to digitalization requires building of an electric circuit that has digitalized measuring instruments. Theraja and Theraja (1999) and Gupta (2008) asserted that instruments used in electrical measurements can be of analogue type or digital type. An analogue instrument is one in which the output or display is continuously variable in time and bears a fixed relationship to the input. Analogue instrument is a deflection type instrument with a scale and movable pointer. The deflection of the pointer is a function of the value of electrical quantity being measured. In analogue instruments, the output can have an infinite number of values within the range that the instrument is designed to measure.

On the other hand, Theraja and Theraja (1999) and Gupta (2008) explained that digital instruments are those which use logic circuits and techniques to obtain a measurement and then display it in numerical reading form. In digital instrument the output (display) can only have a finite number of values since it varies in discrete steps. By displaying the measured quantity in discrete numerals (numbers) in digital readouts, digital instruments eliminate parallax error and reduce human errors associated with analogue pointer instruments. The digital readouts employ either light emitting diode (LED) display or Liquid crystal display (LCD). Some of the advantages of digital instruments over analogue instruments are: easy readability, greater speed, increased accuracy, better resolution, and reduction in operator's errors, automatic polarity and zeroing. However, digital instruments are usually more expensive than analogue instruments.

Measuring instruments commonly used in current electricity are ammeter and voltmeter for current and voltage measurement respectively. The ammeter and voltmeter usually used in senior secondary schools in a standard (conventional) electrical circuit are of analogue type. Digital ammeter and voltmeter (which has advantages over analogue meters) are lacking in senior secondary schools; moreover, modern society is matching towards digitalization. So, there is a need to conceptualize an improvised digitalized measuring instrument for teaching current electricity to physics students in senior secondary schools.

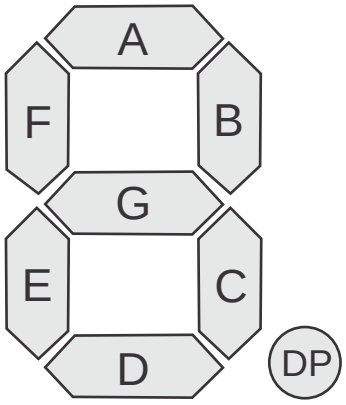
In improvisation of digital ammeter and digital voltmeter, a principle that can be applied to demonstrate the working of digital instrument is open-circuit and closed-circuit principle. It should be recalled that open-circuit does not bring about flow of electric current, and so it is regarded as OFF state; closed-circuit allows the movement of electric current, and so it is regarded as ON state. The two states of "ON" and "OFF" form the basis of digital systems. The "ON" and "OFF" state can be represented mathematically (logically) as '1' and '0' respectively. The use of '1' and '0' as bit in digital circuit shows that a digital circuit is associated with binary system. Theraja and Theraja, (1999) pointed out that the bit 1 may be represented by a saturated (fully-conducting) transistor, a light turned ON, a relay energised or a magnet magnetised in a particular direction. On the other hand, the bit 0 can be represented as a cut-off transistor, a light turned OFF, a relay de-energised or a magnet magnetised in opposite direction. In such cases, there are only two values which a device can assume.

One of the simplest and most popular methods (i.e the best known display method) for displaying numerical digits uses a seven-segment display (7- segment configuration) to form the decimal characters 0 through 9 and sometimes the hex (alphabetic) characters A through F (in a mixture of upper and lower case letters). One common arrangement uses light-emitting diodes (LEDs) for each segment. Light emitting diode (LED) is a semiconductor device and a forward-biased P-N junction which emits visible light when energised. Light emitting diodes emits no light when reverse-biased, and operating LEDs in reverse mode can damage them (Theraja and Theraja, 1999).



Symbol of a light emitting diode (LED)

The segments of seven-segment display are conventionally notated from 'A' to 'G' in the manner shown below. There can be an additional LED provided in the 7-segment display (shown as DP) to display the decimal point. By controlling the current through each LED, some segments will be bright and others will be dark so that the desired character pattern will be generated. For example, to display a "6", the segments A, C, D, E, F and G are made bright by allowing current to pass through them (closed-circuit and On state) while B is made dark by not allowing current through it (open-circuit and Off state); to display a "2", segments F and C will be in OFF state while segments A, B, D, E and G will be in ON state.



Arrangement of seven-segment-display

By adequate configuration and manipulation, several seven-segment displays can be used to form an improvised digital instrument that operates based on open-circuit and closed-circuit principle. Tocci, Widmer and Moss (2007) and Gupta (2008) explained that the wiring pattern of LED seven-segment display is simplified by having one terminal as common for all seven segments. Thus, there are common anode and common cathode internal connections for LED displays. In a common anode type, the anodes of all the segments are tied together to Vcc (power supply line). In a common cathode arrangement, the cathodes of all the segments are tied together and connected to ground. Usually, series resistors are included for each of the LEDs corresponding to the seven segments.

Conclusion

Digital systems and devices such as computer and information technology (eg internet) have helped in the development of human society. Thus, digitalization is an essential activity for sustainable development. Knowledge and skill in digitalization can be obtained through effective education in current electricity (an aspect of physics) and that involves the use of instructional materials. When instructional materials necessary for acquisition of knowledge and skill in current electricity, hence digitalization, are lacking, there is need to embark on improvisation so as to achieve sustainable development. Thus, all stakeholders in education should encourage improvisation in current electricity for exposure of physics students to digitalization necessary for sustainable development.

Recommendations

To encourage and ensure the act of improvisation for exposing physics students to digitalization necessary for sustainable development, it is recommended that:

1 Physics students should have positive interest and attitude towards studies in current electricity and improvisation of instructional materials necessary for the study.

2 Physics teachers should be knowledgeable and skillful in the act of improvisation and be willing to embark on improvisation in teaching of current electricity.

3 Educational administrators (eg principals) should give the necessary support and assistance in improvisation of instructional materials needed to enhance the study of current electricity towards digitalization.

4 Curriculum planners should ensure the design of physics curriculum that reflects on exposure of physics students to digitalization.

5 Ministry of Education should embark on adequate monitoring and supervision in secondary schools to ensure effective teaching and learning of current electricity.

References

Achor, E.E., Taangahar, B.A. & Musa, S.A. (2011) "Relative efficiency of the use of improvised & manufactured analogue voltmeters in the teaching of voltage measurements in secondary school physics" African journal of science technology & mathematics education (AJSTME), 1 (1), 87 - 97.

Ayodele, A.E. (2000) "Effective improvisation in primary school" 41st annual conference proceeding of science teachers association of nigeria, 339 - 341.

Babagbemi, A.P. (2006) "Instructional media an instrument for repositioning education in Nigeria" Multidisciplinary journal of research development, 7 (5), 67 - 70.

Balch, M. (2003) "Complete digital design" New York: McGraw-Hill.

Ekemezie, P. N. (2003). "Newbies information technology" Awka: J' goshen.

Ezeilo, C.J., Chukwulobe, E.E. & Jaja, E. (2013) "Application of electronic technology for economic development" a means for matching towards vision 2020. Journal of research in engineering, 10 (1), 131 – 136.

Falomuwa, A.I., Nwosu, F.C., Nkamuo, C.J. & Adinu, C.A. (2013) "Application of electronics in securing & promoting education in physics" Journal of research in physical sciences, 9 (10), 87 - 92.

Gupta, J.B. (2008) "A course in electronics & electrical measurements and instrumentation" New Delhi: S.K. kataria & sons

Iwuozor, C. (2000) "Enriching science education through improvisation" 41st annual conference proceeding of science teachers association of Nigeria, 45 - 48.

Meadows, R.G. (1978) "Technician electronics 2" London: Cassel ltd.

Okeke, P.N. & Anyakoha, M.W. (1989) "Senior secondary school physics" London: Macmillan education ltd.

Onwudinjo, E.C.U. (2010) "Sustainable development & production industry" Journal of engineering science & technology, 5 (1), 53 – 57.

Theraja, B.L. & Theraja, A.K. (1999) "A textbook of electrical technology" New Delhi: S.chand & company.

Tocci, R.J., Widmer, N.S. & Moss, G.L. (2007) "Digital systems principles & application" New Jersey: Pearson education inc.

World Commission on Environment & Development (1987) "Our common future" London: Oxford university press.