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USING ICT TOOLS IN MINIMIZING COGNITIVE CONFLICTS IN THE LEARNING OF SCIENCE CONCEPTS: IMPLICATION FOR QUALITY TEACHING PARADIGM.

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Abstract
The ICT platform has revolutionized the 21st century workspace. It application in teaching and learning has opened new horizons hitherto unknown. This study investigated the use of ICT study tools in minimizing cognitive conflicts which science learners encounter while learning science concepts. Sixty eight integrated science majors in two intact classes (N= 40, N=28)served as experimental and control groups respectively. A five week treatment programme in three selected concepts often adjudged by science learners as difficult was administered to the experimental class who used various ICT tools while the control group used textbooks as study materials for the concepts. t-test analysis of data generated from a 24-item test of science learning outcome(TSLO)showed no significant difference in outcome of both groups except in two of the concepts (advantage experimental group) when taken separately. Integrating ICT into pedagogic planning and as part of innovation in the 21st century teacher preparation curriculum was recommended.

Introduction

The place of science in global affairs assumes greater dimension with increasing monumental effect by the day. Acquisition of science knowledge and its utilization in improving individual and national lives has become a major goal and aspiration of all. Science implication for sustainable development deepens by the day. Producing quality science learners and products from our schools marks the beginning of the fulfillment of the developmental dreams of any nation. Students ability to learn science concepts as a matter of fact hold the key to acquisition of requisite scientific knowledge as well as developing into useful scientists and science processionals. In other words, the quality of science teaching and learning that take place in our schools determine the quality of scientists and science-related professionals tha will man national developmental affairs in the near future (Nzerem 2000, Moemeke 2010).

Over the years, students' achievement and learning of science has been found to be limited by the extent to which they are able to resolve conflicts that arise as they learn science concepts. Conflicts in science arise when learners are faced with two or more ideas, beliefs opinions and explanations of science phenomena, concepts and issues with each idea, belief opinion and explanation parading evidences in support of it such that the learner is thrown into a state of confusion or mental imbalance as to which evidence out-weights the other or i "true". Truth in this sense relates to relevance to context, currency of evidence, explicability and verifiability. Science learners have been found to experience conflicts in aspects o learning in which there are no specific right answers (Nbina, 2010).In which case, learner are to advance plausible evidence in support of or as explanations for their positions in the discourse. Ability to do this produces authentic science knowledge which is the hallmark of scientific mind.

Nature of Scientific Knowledge

Science refers to individuals' perception, developing, and refining of ideas about scientific issues and phenomena into an integrated perspective that produce enough plausible evidences convincing to the community of science practitioners. In the view of Linn (1998 science understanding requires the ability of the science learners to form models by analyzing linking, connecting, testing and reflecting on ideas. This in Linn (1998) involves effectiveness in making sense of examples, abstractions and principles, and distilling the information that they encounter into cohesion. By so doing, the science learner develops patterns, ideas, heuristics, explanations,/rule-of-thumb which he could use regularly in the face of other science conflicts and challenges. These models are however tentative as they require constant assessment of effectiveness and consequent refinement in the face of new conflicting evidences or as paradigms shift. They however form a basis on which an individual anchors his science knowledge all through life.

Conflicts may rise as learners struggle to make sense of their world and understand the basis for formation of their own models in science concept. Previous attempts to explain issues relating to conflict resolution by science learners have been derived from Psychological (Piaget, 1964; Ausubel, 1963), constructivist (Goodnow,1990; Hennessy 1993) and from cultural anthropological perspectives (Cobern &Aikenhead,1998).The cultural aspect of science learning has been significant especially among science learners from non-western cultures. Geertz(1973)explains science learners as humans animals suspended in a web of significance which they themselves have spun and culture as those webs whose analysis is not an experimental science searching for laws but an interpretive one searching for meaning. Science learners in search of meaning are separated by their cultural microcosm and the experimental world. These limitations produce conflicts which science learners struggle to resolve in the course of making sense and meaning out of science learning. When a current store of knowledge is found to be deficient in explaining some data and information, an impasse is produce which if it does not activate a theory change in the learner, may lead to a negative state of knowledge stagnation, conflict and misconception in science learners (Chinn & Brewer 1998).

ICT in Science Teaching and Conceptual Conflict Resolution

Technology provides new ways by which students/learners engage in learning. According to Gabel (1998) technology increases learners' conceptual understanding of science since it provides opportunities for cognitive restructuring but stresses that the success of its use depends on the level of engagement. Several studies on the effect of computer assisted instruction (CAI) on science learning outcomes and improvement of understanding of science concepts have been recorded. Evidences abound in literature of the use of computer in learning in the following.

1) Problems solving
2) Enhancing understanding
3) As substitute for performing experiments in laboratories
4) In data gathering, analysis, and display, calculating and presenting results.
5) Understanding the world, nature, and natural ecosystem
6) Learning about science through simulations and modeling (Jimba & Ishaleku 2003; Owen, 2003).
7) Understanding diversity and variations among organism.
8) Integrating history and science of live and living.
9) Understanding the nature of science.
10) Understanding the human body and the working of system and organs.

Literature is also replete with evidences that indicate that science learners have been found to benefit immensely from ICT in the following ways:

(1) Attitude towards learning improved due to use of computers in science learning (Dori 1995).
(2) Conceptual change achieved in understanding of chemical equilibrium (Hameed, Hacking and Garnett 1993).Better laboratory performance achieved through videotapes (Russell, Staskun and Mitchell 1985).

Jimba and Ishaleku (2003) in their review of Leicester (2003) and Efedi and Moemeke (2010) explicated that science learners utilize ICT facilities while learning science to:

(1) Ask questions, predict phenomena, and hypothesize
(2) Observe, measure, record, and manipulate variables.
(3) Interpret their results and evaluate scientific evidence.
(4) Present and communicate their findings in a variety of ways.

ICT use in helping science learners extend their knowledge of science and overcome certain conceptual conflicts while navigating science knowledge especially by non- western culture science learners has been achieved through:

- Simulations and modeling (Jimba & Ishaleku 2003).

- Data logging for measurement, hypothezing, and evaluation of results (Denby,2002)
- Data bases and spreadsheets for data organization, information sorting, quick processing of information and easy identification of patterns.
- Publishing and presentation devices such as MS word processors, desktop publishing package, and multimedia authoring software.
- Information resources such as internets, CD ROM, data files for information search which lead to knowledge extension and conflict overcome (Denby 2002).

The attributes of ICT which contribute to is positive effect on students learning as identified by Moemeke (2010b) include

(1) Affording speed and accuracy in learning of concepts
(2) Convenience as student can tackle difficult concept without aid (individualization of learning).
(3) Comprehensiveness of learning since information/knowledge is drawn from varied sources.
(4) Innovativeness in learning strategies that are learner specific
(5) Interest in themes from diverse disciplines in explaining phenomena.
(6) Tracking of information from different sources.
(7) Transferability of learning from one domain to others.

The focus of this study is to determine if these attributes actually translate into meaningful learning.

Statement of the Problem

Science is a dynamic discipline. As new evidences about phenomena are discovered, paradigms change along with body of knowledge associated with it. Science learners are therefore always in a constant search for new and easier ways of making sense out of classroom activities. Teachers on the other hand seek more appropriate and effective strategies for helping learners acquire authentic and productive science knowledge. As the needs of learners and society change, the need for pedagogic approaches to bring about the change also arises. Some science education literatures (Moemeke & Omoifo 2009,Moemeke 2009, Nnaobi 2003) have identified instructional model, strategy or approach as primary in helping learners make sense of science concepts as well as improve science learning outcomes. Apart from this, lack of and non use of instructional materials, poor teacher knowledge of science concepts and pedagogy, students utilization of poor learning modes as well as poor attitude towards science have been shown to affect science learners learning outcome. Moemeke (2009) in an earlier study showed that biology students positive response to laboratory manuals fortified with visual information processing aids was due to the help which it offered the science learner in reducing hindrances in information processing of textual material. If this is the case, then ICT tools which have been acclaimed to posses the qualities of

(1) Information possessing and information sourcing.
(2) Providing instruction/learning options through multi-channel learning.
(3) Options and help in observing measuring, recording and manipulating variables
(4) Interpreting results and evaluating scientific evidence
(5) Presenting and communicating finding are likely to present new venues for learners to overcome difficulties in the learning of some identified difficult concepts especially in the face of persistent dearth of adequate instructional materials in schools. This study therefore asks the questions: will the use of purposeful CD ROMs and computer simulation help students overcome perceived difficulties in learning science concepts? This is the focus of the study.

Research Questions

This study was guided by the following research questions:

(1) What is the effect of use of ICT tools in science learning outcome of students?
(2) Is there any difference in science students' achievement in previously identified difficult concepts due to use of ICT tools?

Research hypotheses

The following hypotheses were tested in the study

(1) The use of ICT tools has no significant effect in science students' learning outcome
(2) Science students' achievement in identified difficult concepts did not differ significantly among ICT tool users and non ICT tool users.

Method of the Study

The sample consisted of sixty eight (68) students of integrated science department of five colleges of education in Nigeria in the 2008/2009 academic session. Forty (40) subjects in the sample who had personal computers formed the experimental group. The experimental group studied three integrated science concepts (particulate nature of matter, energy in living systems, and reflection of light) for five weeks. The remaining twenty eight (28) students studied the same concepts using texts prepared by the researcher. Post test data was collected using a researcher constructed and validated test of science learning outcome (TSLO), a 24-item multiple choice instrument. The reliability of TSLO was found by KR 21 to be 0.67.

Results

Table 1: t-text analysis of learning outcome by group.

Groups	N	$\bar{X}$	SD	df	Cal.t-value	Table value	Sig t
Experimental	40	12.56□	38.60	66	0.21	2.0	
Control	28	&t	9.10				
		10.50					

*Significant a p≤0.05

Table 2: t-test analysis of achievement in perceived difficult science concepts by group.

Topics	N	$\bar{X}$	SD	df	Cal.t-value	Table value	Sig t	
Particular nature of matter	Experiment	40	8.95	1.739	66	5.40	2.00	.000*
	Control	28	6.79	1449				
Energy in living systems	Experiment	40	9.38	2.075	66	.10	2.00	0.00*
	Control	28	7.57	1.794				
Refraction of light	Experiment	40	75.83	6.92				
	Control	28	75.64	8.11	66	0.21	2.00	.92

*Significant at p ≤ 0.05

Table:1 shows a no significant difference (t=0.21 df 66) in the learning outcome of science students who studied selected concepts using ICT tools and those who studied the same concepts without ICT tools. Though the experimental group (ICT users) produced a higher mean (X = 12.56) compared to the control group (X = 10.56), the difference was found not to be significant at the 0.05 level of significance used for the study. The null hypothesis was therefore retained.
Table 2 which presented the results based on the three perceived difficult science concepts in this study, showed a significant difference in the learning outcome of the experimental (ICT tool users) and the control (non-ICT users) in two out of the
Three concepts investigated. A significant difference (t=5.40 df 66) was found between the experimental and control groups at 0.05 alpha level in particulate nature of matter as well as in energy in living systems (t = 3.74 df 66). In both cases, the experiment group produced superior means (8.59 and 9.38 respectively) compared to the control group's means (6.79 and 7.57 respectively) in both topics. The difference in the third concept (Refraction of light) was however found not to be significant at the 0.05 alpha level (t = 0.10 df 66).The mean difference in student outcome (0.19) was not significant at the 0.05 level of significance.

Discussion of Results

The findings from this study showed that while ICT users did not perform significantly better than the control group, evidence in mean reveal an appreciable difference in favour of the experimental group. The non significance of the difference may be attributable to the short period of the study (5 weeks). The researcher believes that an extended study will provide opportunity for difference in learning to manifest statistically as knowledge develops cumulatively over time. More important to this study however is the significance of the difference found in subjects learning outcome of some perceived difficult science concepts. Subject understanding of abstract concepts such as particulate nature of matter and energy in living systems was enhanced by their use of ICT learning tools as students were able to conceptualize them as well as make meaning out of them. This finding conforms to Denby (2002), Nnaobi (2003), Moemeke (2009, 2010). These studies have showed variously that learners require some visual interpretive assistance to enable them form models upon which they anchor their knowledge of abstract concepts. Conflicts, misconceptions, and consequent poor performance in science concepts are traceable to difficulties in mental processes required for conceptualizing abstractions in science. This activity has been found by Hameed et al (1993) to be cumbersome for some science learners. The computer and other technologies relieve the learners of this task by helping them sort, arrange, source, interpret and analyze information as well as providing the necessary prompts, and attitude boosting devices which learners need to continue to learn science.

Conclusion

Teaching science to modern day children is challenging. This is because the learners now are different from all generations before them. This is why Coutinho and Junior (2009) referred to them as 'digital natives' while their teachers are 'digital immigrants'. Teachers who did not learn science by ICT tool utilization must realize and be aware of the great potentials which ICT holds in learning of science. This study has shown that teachers knowledge of how to integrate technology into content teaching and learners use of this integrated learning hold the key to learning science comprehensively, effectively, and with ease. This study has shown that ICT integration and use for teaching and learning in the science classroom provide the students what they need to help them overcome some mental obstacles when learning science. Quality teaching of science must therefore integrate ICT tools into science curriculum delivery thus providing the learners wider horizon for sourcing, retrieving, organization and use of science knowledge in this age.

Recommendation

The task of conceptualizing abstract concepts is science is enormous. Quality teaching should integrate ICT into pedagogy so as to help learners learn science concepts with ease.

ICT tools within teachers' pedagogy will help

(1) Increase learners motivation

(2) Increase communication by learners inside and outside the classroom. (3)

(3) Creates debate and give users opportunity to participate in science debates.

(4) Knowledge sharing across the globe

(5) Creates space for posting of information by learners.

These benefits are too important to be overlooked. Teachers should therefore not only use ICT tools in their everyday task, but build ICT into the content and pedagogic tasks during classroom activities especially in those areas perceived to be difficult.

As a result of this, the 21st century teacher should be digitally empowered and skillful in digital pedagogic integration so as to effectively utilize the omnibus ICT tools. This goes beyond mere possession of ICT training but to its integration into teaching and being able to read and write multiple forms of media and integrating them into a meaningful whole which is the basis for modern science knowledge.

Availability of ICT tools for, use in the classroom should be taken very seriously. No meaningful learning of science in this age can occur when learners are ignorant of the great digital opportunities and knowledge offered by the web, internet, and other ICT tools.

The cost of installing, using, and accessing the net should be brought to the reach of all, so as to promote easy access to and use by all. No matter how it is viewed, it is cheaper than the consequences of producing digitally marginalized future national workforce and illiterate science graduates.

The curricula of teacher training institutions in Nigeria should be reviewed to make training in ICT related pedagogy a basic component. This is because digitally wise teachers are likely to produce quality and digitally wise science graduates.

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