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USE OF WEB-BASED MULTIMEDIA AND LEARNING OUTCOMES IN CELL BIOLOGY

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ABSTRACT
Two teaching models were evaluated for their effectiveness on students' learning outcomes in cell biology. Twenty NCE one students of the Department of Integrated science, Federal College of Education (Technical) Omoku were systematically selected and divided into two groups for the study. The experimental group and control groups were taught using the Web -based multimedia [WBM] and conventional model respectively. Both groups were evaluated with a 20-item "Mitosis Importance and Stages achievement Test" [MISAT]. The MISAT scores, which constituted the data for the study was analyzed for mean achievement. Result indicates that students taught with WBM model performed slightly better than those taught using CM, although the teaching models did not significantly affect their achievement. Also, t*wo* –Way ANOVA statistic for interaction between gender and learning outcomes based on both models showed lack of significant difference ($p>0.05$). Irrespective of the learning model used, the mean scores of females were significantly higher than their males counterpart ($p<0.05$). The higher performance of the experimental group is significant for scientific literacy, and therefore, the authors recommend that teaching models should involve use of multi-media which engages all sense organs, stimulate interest and enhance understanding of living cells, cellular activities and applications of biological processes to better human wellbeing.
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KEYWORDS: Achievement, Cell biology, Conventional, Gender, Web-based multimedia, Mitosis, Model

INTRODUCTION
Living organisms are made of trillions of tiny structures referred to as cells. Cells have been defined as the 'basic unit of life'. Each cell is unique on its own and performs varying functions. The study of cells can be considered as one of the most important areas of biological research (Vodopich and Moore, 2015).Cell Biology is the aspect of biology which focuses on structure, and functions of living cells and cellular processes involved in growth and development (mitosis, meiosis), transport of materials (osmosis, diffusion, active transport etc) and regulation. Cell biology covers all aspects including cell physiology, cytometry, cellular structures, microscopy, cellular types, systems biology central to many science courses such as medicine, biochemistry, pharmacy, nursing etc. The studies of cells enhance an understanding of the science of genetics and variations, metabolic activities, biotechnology, pathogenic disease production and control to mention but a few. Certain substances e.g. aflatoxin, radiations or chemicals can cause cellular disorders or damage to genes, which are located on chromosomes in cells. According to British Society for cell Biology (BSCB) (2015), by understanding how cells work in healthy and diseased states, cell biologists will be able to develop new vaccines, more effective medicines, plants with improved qualities and through increased knowledge a better understanding of how all living things live.

Students learn through various methods (auditory, visual, and kinetic (Kearsley, 1996), therefore, the use of animation and associated sounds may present the concept more effectively than static illustrations or reading of text (Aderson, 2001; Robinson et al, 2008; Nkweke et al, 2012). Cells are microscopic in nature. It is practically impossible for a student to understand how cells are without visualization of some sort or how they function without some simulations or experimentation. This is where the biology laboratory is a unique resource for cell study (Kerbyson et al, 2001). Certain biological processes are more easily presented through the use of motion than with a static illustration. More specifically, animation clarifies those processes involving motion for example, the movement of polymerases along DNA or the ribosome along mRNA, or mechanism of enzyme action. The latter as shown in figure 1 is an illustration of protein structure, enzyme (E) and the induced fit model for enzyme action. The induction and binding movement is best depicted and appreciated by a multi-media to visualize changes in shape of enzyme's active site as induced by various R groups of amino acids on the enzyme when the substrate (S) binds.

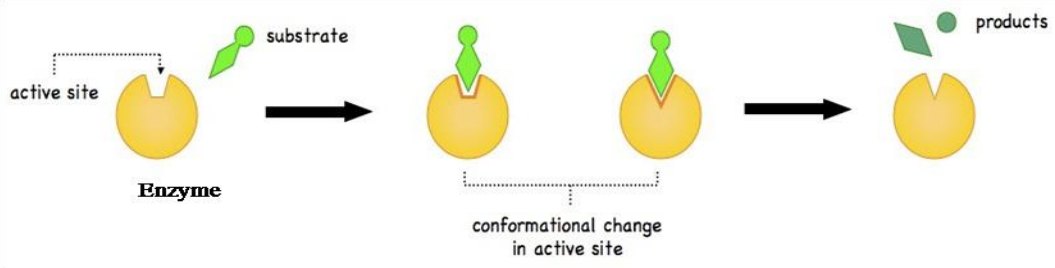


Figure 1. The Induced Fit Model

Source: http://www.vce.bioninja.com.au/aos-1-molecules-of-life/biochemical-processes/enzymes.html

Cell Biology is full of topics which can be studied both virtually and in real time in the laboratory by the use of microscopy techniques. An example is mitosis, a type of cell division that occurs in somatic cells. Figure 2 shows the five stages of mitotic division. A mere chart like this alone may not make much sense but would do a great deal if it is animated/interactive using a multi-media and students would visualize and appreciate the nature of actively dividing cells, the shapes and arrangement of chromosomes, formation of spindle fibres, movement and alignment of chromosomes and eventual cytokinesis as shown in photo shots from web-based animations below.

Figure 2. Stages of Mitosis

Computer simulations and multimedia are of utmost importance in the study and demonstration of cell structures, processes and functions. The concepts are presented to the students in such a well organized and interesting manner that makes for greater clarity and easier understanding. There are numerous e-learning resources available on the internet for this purpose. An example is http://www.biology.arizona.edu/cell_bio/tutorials/cells/cells3.html. Readers should check http://homepages.gac.edu/~cellab/links.html for other listings.

In this study, students are exposed to web-based multimedia interactive learning on the stages of mitotic divisions in somatic cells and evaluated for level of understanding and learning outcome. It is hypothesized that there will be no significant difference between students using web-based multi-media, tutorial and animations (experimental group) and those taught using static illustrations such as picture chart(control group) and that there will be no significant difference between male and female students in both study groups.

METHODOLOGY

Study Design

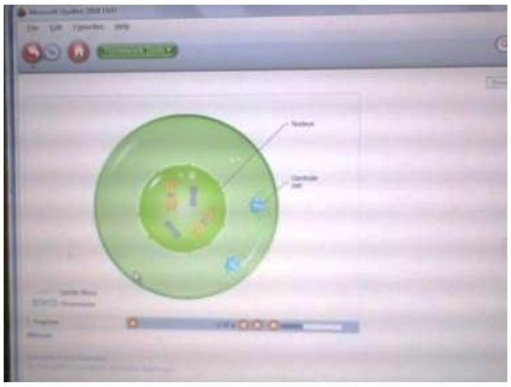
The study was a quasi- experimental type in which two groups of students were exposed to web-based interactive multimedia and mere static illustrations to learn the stages and importance of mitosis respectively.

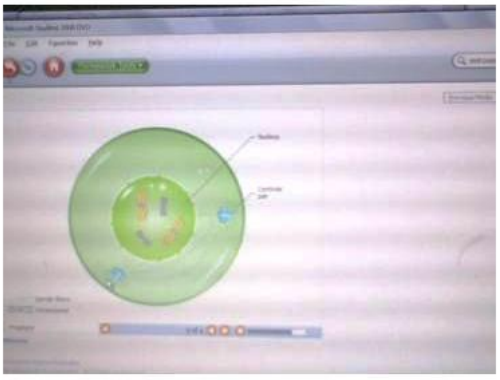
Study Population and Sample: The study population comprises students in the Department of Integrated science students in Federal College of Education (Technical), Omoku. Study sample was limited to twenty (20) NCE I students were used for the study. The students were divided into two groups –experimental and control group sample, which consisted of ten males and ten females.

The Learning Model

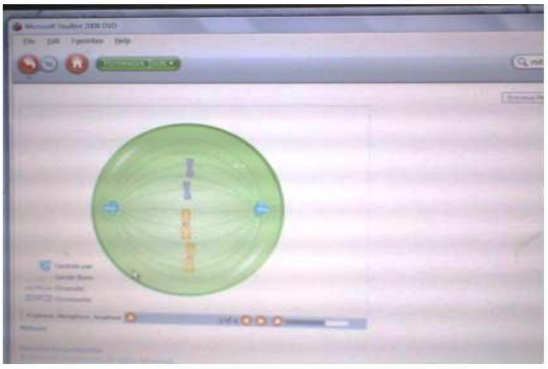
Model 1: Microsoft Encarta ® 2009-2012 multimedia on Mitosis (Cell Division) was used to teach different stages of mitosis to the experimental group. The media had four stages (1-4) which when the "play" button is clicked on, runs progressively with narration until it finishes. The media was projected from Labtop HP computer to a white board for the experimental group to watch, make note, discuss and asked questions .By clicking on "stop", "pause" or "repeat" button, it enabled the learner to follow the animations at his/her own pace. Photo shots from the projected multi-media animations are shown below:

Introduction of Mitosis

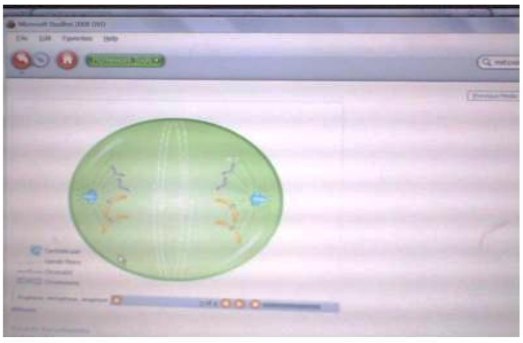


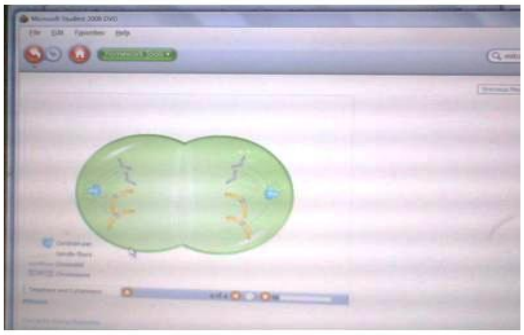


Prophase- 1st stage of mitosis



Metaphase- 2nd stage of mitosis





Anaphase – 3rd stage of mitosis

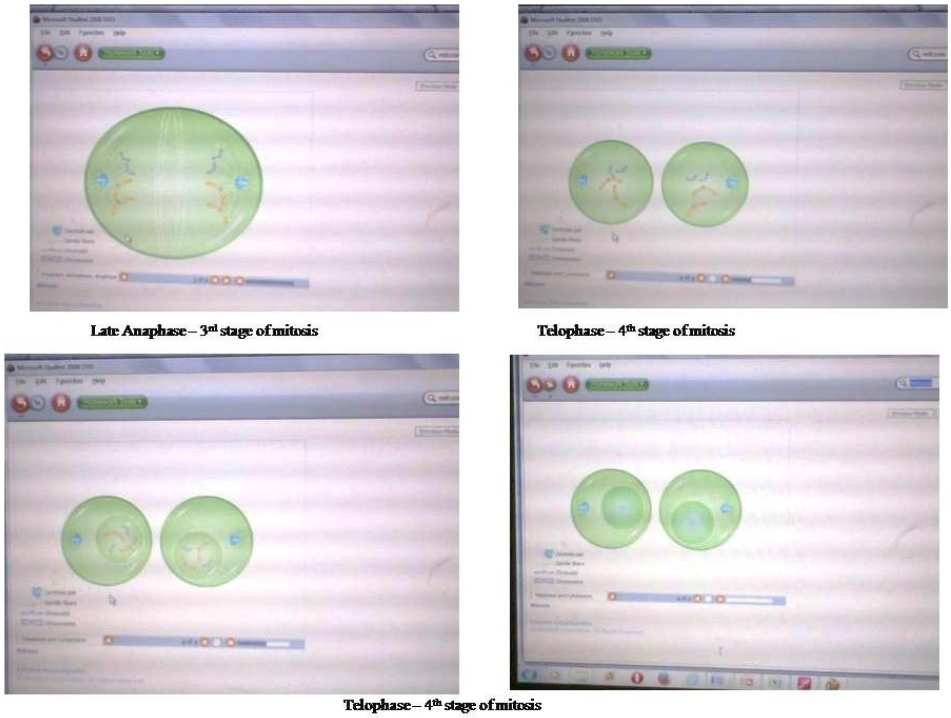


Figure 3. Photoshots of interactive/animated Stages of Mitosis
Source: Ferguson (2007)

Model 2: The control group was taught using conventional lecture method without chart or multimedia animations.

Research Instrument
The instrument used to evaluate learning outcome was a "Mitosis Stages and Importance Achievement Test (MISAT), which consisted of twenty (20) subjective questions designed for students to provide the correct answer from a list provided (see appendix 1). The questions were drawn from 2-3 web addresses, namely, Biology quiz: mitosis available at http://www.syvum.com/cg/online/multiple; http://www.syvum.com/cgi/online/serve.cgi/squizzes/biology/celldiv.html

Validity of the Instrument
The research instrument was validated for both face and content validity based on the specified learning objectives.

Method of Data Collection
The two groups of learners were subjected to the same test and graded as percentage. Scores obtained constituted the data for the study.

Statistical Analysis
The data collected for this study was analyzed using descriptive statistics and analysis of variance (ANOVA) statistics. A 2-way analysis of variance was used to determine the interaction between gender and learning method at 0.05 level of significance.

Analysis was done using Microsoft Excel Data Analysis Pak and Real Statistics Software.

RESULTS AND DISCUSSION
The mean achievement of male and female students taught using WBMM and CM is presented in figure 1.

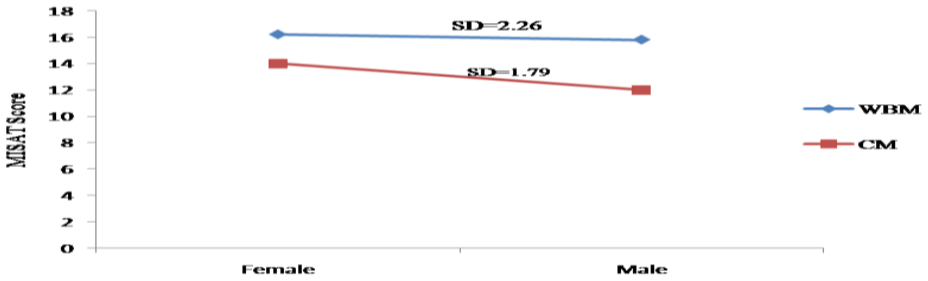


Figure 1. Mean MISAT Score for Male and Female Taught with Web-based media model and Conventional Model

Key: SD=Std dev; MISAT=Mitosis Importance & Stages Achievement Test; WBM= web-based media model; CM= Conventional model

From the mean plot of test scores (figure 1), students taught using WBM model performed better than those taught using CM. It was hypothesized that there would be no significant difference in the achievement of male and female students taught using conventional model. A Two-way ANOVA statistic for both gender effects on the two teaching models is shown in table 1 below:

Table 1. Two- Factor ANOVA Statistic for Gender Interactions with Achievement in Cell Biology using Web-based Media and Conventional Models

ANOVA				Alpha	0.05	
	SS	*df*	*MS*	*F*	*p-value*	*Sig*
Gender	45	1	45	10.65089	0.00488	Yes
Models	7.2	1	7.2	1.704142	0.210208	No
Inter	3.2	1	3.2	0.757396	0.397014	No
Within	67.6	16	4.225			
Total	123	19	6.473684			

Mean scores show that females scored slightly higher than males in both instructional models adopted for the study (16.2>15.8; 13.8>12.5) respectively. F statistic indicated that there was significant difference in learning outcome based on gender and instructional models used ($p<0.05$). Although, the experimental group had a higher mean score in MISAT, there was no significant difference between both experimental and control groups, neither was there any significant interaction between gender and instructional models adopted ($P>0.05$).

DISCUSSION

The result indicates that students exposed to web-based animations and tutorials are more effective than those taught with traditional classroom teaching. The result is consistent with those of Stith (2004) and Adedamola, (2015) who observed high level of attainment in learning outcome in biology. In a related study, Yusuf and Afolabi (2010) showed that the performance of students exposed to CAI either individually or co-operatively were better than their counter parts exposed to the conventional classroom instruction. However, no significant difference existed in the performance of male and female students exposed to CAI in either individual or cooperative settings. Cheng et al (2012) also reported that when compared to traditional models of instruction, students using the multimedia computer - assisted instruction model scored significantly better in learning achievement assessments in biology but however observed that students exposed to the same variety of learning styles performed better when exposed to only multimedia computer assisted instruction model. On the contrary, Owusu et al (2010) reported that although students instructed by conventional method performed better on a post-test than those instructed by the CAI, low achievers within the experimental group improved their performance after being instructed by the CAI. On average, some classroom researcher suggests computers can offer highly individualized instruction and allow students to learn at their own pace (Seweje, 1987; Lepper and Gurtner, 1989; Means and Olson, 1995; Sandholz et al, 1997; Heath and Ravits, 2001). The findings of this study confirms various reports that students perform better when they see and visualize what is being learnt in a real life situation like the use of projector, video clips etc. Besides, it is believed that the work load of teachers will be lessened if they effectively know how to use the computer very well (Russel, 2004), and will bring about high academic achievement in the part of the students.

CONCLUSION

The result of the study showed that students taught with web-based multimedia performed better than those taught using traditional method. This finding lends support to the enhanced teaching and learning made possible by educational technology. Also, female students did better than male students, although there was no significant difference between the experimental and control groups. Based on the above, the researchers recommend that teachers should expose both male and female students to educational technologies, which are very much available on-line and play down on the traditional talk-chalk method. To make use of technology possible, computers and internet facilities should be provided and also, teachers should attend workshops regularly to update their knowledge. The issue of power should also be addressed to enable use of the e-learning media to attain stated instructional objectives.

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APPENDIX

Appendix 1: MISAT Instrument

Mitosis is a process in which a cell's …(1)…… replicates and -----(2)------ in preparation for division of the cell. Mitosis results in ---(3)----- cells that are genetically –(4)----------, a necessary condition for the normal functioning of virtually all cells. Mitosis is vital for ---(5)---------; for ----(6)-----of damaged or worn out cells; and for ---------(7)----------. Mitosis occurs in four steps: -----(8)-----, ---(9)-------, ----(10)-----, and ----(11)-------. In prophase, the replicated, linked DNA strands slowly wrap around proteins that in turn coil and condense into two short, thick, rod-like structures called -------(12)--, attached by the ------(13)---. Two structures called --------(14)----, both located on one side of the nucleus, separate and move toward opposite poles of the cell. As the centrioles move apart, they begin to radiate thin, hollow, proteins called --------(15)------. The microtubules arrange themselves in the shape of a football, or spindle that spans the cell, with the widest part at the center of the cell and the narrower ends at opposite poles. In metaphase, exactly half of the chromatids face one pole, and the other half face the other pole. This equilibrium position is called the …(16)….. Anaphase begins when the centromeres split, separating the identical chromatids into single chromosomes, which then move along the ---------(17---- to opposite poles of the cell. At the end of anaphase, …(17).. identical groups of single chromosomes congregate at ----------(18)----- poles of the cell. In telophase, the final stage of mitosis, a new ……(19)---. forms around each new group of chromosomes. The spindle fibres break down and the newly formed ------(20)---chromosomes begin to unwind. Mitosis accomplishes replication and division of the nucleus, but the cell has yet to divide.