International Journal of Innovative Social & Science Education Research 12(4):9-16, Oct-Dec, 2024

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DOI: 10.5281/zenodo.13925801

Effectiveness Of Technology-Enhanced Learning (TEL) Tools In Perceiving Cell Biology Concepts Among Students Of Hassan Usman Katsina Polytechnic, Katsina State

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ABSTRACT

This study seeks to investigate the effectiveness of Technology-Enhanced Learning (TEL) tools in perceiving cell biology concept among HND II SLT Microbiology (option) students of Hassan Usman Katsina Polytechnic, Katsina State. Two specific objectives, two research questions and one null hypothesis were formulated to guide the study, A mixed method approach was employed for the study. A total of forty-four (44) students were used as the population and sample of the study. An Adapted structured questionnaire; Computer Animation Learning Approach (CALA) and a standardized Biology Achievement Test (BAT) were used for data collection. Both the test instruments were tested for validity and reliability respectively. The data was then analyzed using simple frequency, mean and standard deviation, and t-test paired test using SPSS. The findings indicated that TEL tools significantly improve students' comprehension of cell biology concepts. Consequently, it is recommended that Technology-Enhanced Learning (TEL) tools should be integrated in teaching and learning of cell biology among students.

Keywords: Effectiveness, Technology-Enhanced Learning (TEL) tools, Perceiving, Cell biology concept

INTRODUCTION

Cell biology is a fundamental subject in modern life sciences that examines the essential life processes of cells at the microscopic, submicroscopic, and molecular levels. As the basic unit of all living organisms, cells are where life activities occur, and diseases often result from abnormal cellular changes (Veselinovska, Gudeva & Djokic, 2011). Therefore, a cell biology course focuses on understanding the cell as the basic unit of life, exploring the composition of the nucleus and cytoplasm, and studying different types of cell division and their significance. Moreover, the course also includes the study of chemical reactions within a cell, the structure and function of the cell and its org d rep

Effective learning in the natural sciences is closely tied to the teaching methods employed by both instructors and learners. The rapid increase in information has led to a constant evolution of the educational paradigm, driven by ongoing social and technological changes (Veselinovska, Gudeva & Djokic, 2011). These tools enable students to visualize and manipulate biological processes in real-time; for example, they can examine cell structures, observe cellular activities like mitosis and meiosis, and comprehend molecular interactions through 3D models and animations. Teachers should

not be concerned about "losing" or "wasting" valuable lecture time on teaching activities that may take time away from covering content (Lujan & DiCarlo, 2006). Activities such as in-class discussions, collaborative problem-solving, and inquiry-based learning help students focus on applying scientific knowledge to solve posed questions. This approach is crucial because learning isn't just about memorizing facts, but about developing the ability to find, evaluate, and apply information effectively.

In line with UNESCO's (2002) recommendation to enhance science education through diversifying content and methods, promoting experimentation and innovation, and sharing information, these principles can also be applied to the teaching of biology. The diversification of content and methods, along with innovative approaches, can be achieved by integrating technology into biology instruction. Traditional teaching strategies in science have often failed to effectively foster problem-solving skills, curiosity, and critical and logical thinking among students (Shan & Khan, 2015). This has created a strong need for a shift toward technology integration as a new pedagogical approach. In particular, the integration of Information and Communication Technology (ICT) is crucial, as teaching fundamentally involves the transmission of information through communication.

Empirical studies highlight significant challenges that learners face in acquiring knowledge (Anderman et al., as cited in Veselinovska, Gudeva & Djokic, 2011). Specifically, the cognitive demands of organizing and elaborating—integrating new information with existing knowledge—are particularly challenging for students, especially when learning requires conceptual reasoning (Yoon et al., 2017). Research and effective teaching strategies suggest that cell biology instructors should move away from the misconception that they must "cover all the content" to adequately prepare students for the future and to be successful as educators. Advances in technology enable pedagogical enhancements that some believe can revolutionize traditional methods of teaching and learning (Gatlin-Watts, Arn, Kordsmeier, 1999; Persin, 2002, as cited in Angadi & Ganihar, 2015).

Statement of the Problem

Cell biology is a course that encompasses both the theoretical and practical aspects of studying the basic aspects of cell. For students pursuing a National Diploma in Science Laboratory Technology (SLT) and intending to advance to a Higher National Diploma (HND) in SLT (Microbiology option), a solid understanding of cell biology concepts is essential. Although practical experiments and visual understanding are essential for mastering cell biology concepts, many institutions face challenges in offering sufficient hands-on experiences due to limitations in time, budget, and resources.

Traditional teaching methods for cell biology often encounter challenges, such as limited laboratory resources, difficulty visualizing complex cellular processes, and addressing the diverse learning needs of students. This approach may not sufficiently engage all students, especially those who thrive in interactive and multimedia-rich learning environments. This can result in differences in students' understanding and retention of essential biological concept.

As a matter of fact, the increased development in Information and Computer Technology (ICT) may be of great importance in diversifying the method of teaching and learning cell biology concepts. Different technology- enhanced learning tools such as; virtual laboratories, videos, animations, and interactive tutorials can present cell biology concepts in a dynamic and engaging manner. These resources cater to different learning styles, aiding students in comprehending complex information through visual and auditory methods.

Considering the diverse learning preferences and abilities among students, technology-enhanced learning (TEL) tools must be designed to accommodate various learning styles to effectively engage everyone. To address the diverse learning preferences, the researcher aimed to explore the use of Technology-Enhanced Learning (TEL) as a way to incorporate digital tools and resources into the educational process, offering innovative solutions for effective teaching and learning.

Aims and Objectives of the Study

This study aimed at investigating the effectiveness of Technology-Enhanced Learning (TEL) tools in perceiving cell biology concepts among students of Higher National Diploma (Microbiology option) Science Laboratory Technology, Hassan Usman Katsina Polytechnic, Katsina.

The specific objectives of the study include:

a) To find out the effectiveness of TEL tool in perceiving cell biology concepts among students

Research Questions

1. What is the effectiveness of Technology-Enhanced Learning (TEL) tools in perceiving cell biology concepts among students?
2. How do students' learning outcomes differ when using Ideogram as compared to Computer-Animated Media Package as TEL tools?

Research Hypothesis

Based on the research questions stated one null hypothesis was formulated for testing at $p \leq 0.05$.

H_O1: There is no significant difference in the student's learning outcomes when using Ideogram as compared to Computer-Animated Media Package as TEL tools in perceiving cell biology concepts.

METHODOLOGY

This study adopts a mixed method approach by combining survey and experimental design. By using both methods together, the study aims to strengthen its overall findings more effectively than relying solely on either qualitative or quantitative research (Creswell & Plano Clark, 2007).

The Higher National Diploma (HND) II 2022/23 students of Science Laboratory Technology (Microbiology option), Department of Basic and Applied Sciences, HUKPoly were employed as the respondents of this study. A total of forty-four (44) students was obtained from the Examination Office. All the 44 students were selected as sample of the study using convenience sampling.

The methods of data collection were:

a) Adapted structured questionnaire (Computer Animation Learning Approach, Opeyemi et.al, 2022) a ten (10) item of 5 point likert-scale. The test instrument was validated based on it's face and content validity by experts in the field. Where a co-effient of 0.79 was obtained using test-retest method for it's reliability.

b) A controlled experiment (post-test only experimental design). The topic treated was cell division: meiosis II (gametogenesis and fertilization).The students were tested after using Ideogram and Computer Animated Media Package as experiment I and II respectively. Using a standardized Biology Achievement Test (BAT) which consists of 20 multiple-choice questions on Cell Division with four multiple choice questions to answer. To ascertain the reliability of the test instrument, a coefficient of 0.72 was established using the Kuder-Richardson (KR 20) formula. The instrument was then used as the post-test in the study groups.

The data collected were analyzed using Statistical Package for Social Sciences of which simple frequencies, percentages, mean and standard deviation for descriptive and inferential statistics while paired t-test was used to test the null hypothesis.

RESULTS

Table 1: Bio data of the Respondents

S/N	Statement	Option	Frequency	Percentage
1.	Gender	Male	27	61.4
		Female	17	38.6
		Total	**44**	**100.0**
2.	Age	15-20 years	1	2.3
		21-25 years	34	77.3
		26-30 years	6	13.6
		31 yrs and above	3	6.8
		Total	**44**	**100.0**
3.	Most suitable TEL Tool	Computer-Animated Media Package	30	68.2
		YouTube videos	4	9.1
		Ideogram	10	22.7

Table 1 shows the demographic data of the respondents, where 27 participants (61.4%) were male, and 17 (38.6%) were female. The majority, 34 participants (77.3%), were aged 21-25. Regarding

technology-enhanced learning (TEL) tools, 30 participants (68.2%) found the Computer-Animated Media Package most effective for understanding cell biology concepts, while 4 participants (9.1%) preferred YouTube videos, and 10 participants (22.7%) found Ideogram to be more effective. In conclusion, the Computer-Animated Media Package was considered the most effective TEL tool for learning cell biology, as illustrated in Figure **1.**

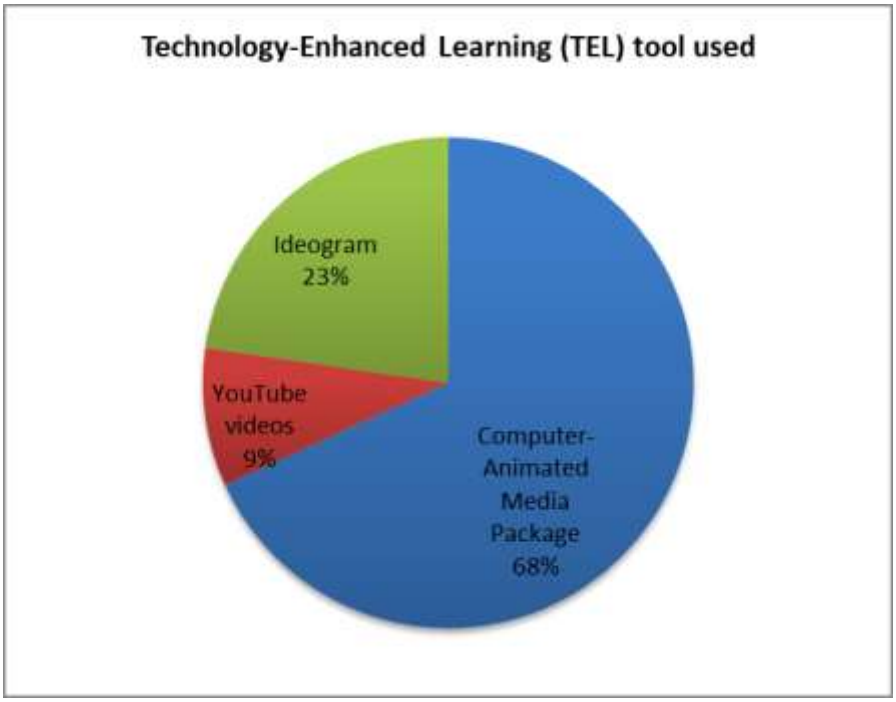

Figure 1: Pie chart showing the most suitable TEL Tool used

Answers to the research questions

RQ1: *What is the effectiveness of Technology-Enhanced Learning (TEL) tools in perceiving cell biology concepts among students?*

Table 2: Effectiveness of (TEL) tools in perceiving cell biology concepts among students

	N=44	**5**	**4**	**3**	**2**	**1**				
S/N		**SA**	**A**	**N**	**D**	**SD**	**FX**	**Mean**	**Sd**	**Remark**
1.	I like the CALA in learning cell division concepts in Biology.	24	17	0	0	3	191	4.34	1.84	Agreed
2.	The cell biology concepts are clearer and understandable when taught with Cell Division.	30	10	0	0	4	194	4.41	1.91	Agreed
3.	I like this teaching method using CALA than when the conventional lecture method is used.	28	9	6	0	1	195	4.43	1.93	Agreed
4.	I don't like this teaching method using CALA than when the conventional lecture method is used.	1	6	10	13	14	99	2.25	-0.25	Dis Agreed
5.	CALA has changed my thinking about the difficulty of cell division concepts.	26	10	3	4	1	188	4.27	1.77	Agreed
6.	I am curious and motivated during learning when CALA is used in teaching cell division than the conventional lecture method.	29	6	0	4	5	182	4.14	1.64	Agreed
7.	Teaching cell division concepts using CALA makes its learning process more interesting and easier.	29	9	5	1	0	198	4.50	2.00	Agreed
8.	The use of CALA is motivating to me in learning cell division concepts in Biology.	34	7	3	0	0	207	4.70	2.20	Agreed
9.	The different pictures used to explain different phases of mitosis and meiosis make me lose interest in the package.	7	3	5	10	19	101	2.30	-0.20	Dis Agreed
10.	Learning Cell division using CALA has made me developed an interest in choosing Biology teaching as my future carrier.	27	5	7	2	3	183	4.16	1.66	Agreed
	Grand Mean							**4.10**	**1.60**	**Agreed**

Table 2 reveals that respondents generally agreed on the benefits of CALA (Computer-Assisted Learning Approach) in learning cell division concepts. They expressed a strong preference for this method, with a mean rating of 4.34 (standard deviation 1.84). They also found cell biology concepts clearer when taught with CALA, with a mean of 4.41 (standard deviation 1.91). Respondents favored CALA over conventional lectures, with a mean of 4.43 (standard deviation 1.93). However, they disagreed with the statement that they dislike CALA compared to traditional lectures, reflected by a mean of 2.25 (standard deviation -0.25). Additionally, they felt CALA changed their perception of cell division as a challenging topic (mean 4.27, standard deviation 1.77) and found it more engaging and motivating, with a mean of 4.14 (standard deviation 1.64). Overall, CALA made learning cell

division more interesting and easier, as indicated by a mean of 4.50 and a standard deviation of 2.00. The use of CALA proved highly motivating for students learning cell division concepts, with a mean score of 4.70 (standard deviation 2.20). Respondents disagreed with the notion that the images used to illustrate phases of mitosis and meiosis diminished their interest, with a mean of 2.30 (standard deviation -0.20). Additionally, learning cell division through CALA sparked students' interest in pursuing a career in Biology teaching, with a mean of 4.16 (standard deviation 1.66).

RQ2: *How do students' learning outcomes differ when using Ideogram as compared to Computer-Animated Media Package in perceiving cell biology concepts?*

Table 3: Achievement Test Scores using Ideogram (EXP. I) and Computer-Animated Media Package (EXP. II)

TEL tool	0-5 Marks	6-10 Marks	11-15 Marks	16-20 Marks	Mean	N	Std. Dev.
1. Ideogram	1	20	16	7	11.02	44	3.17
2. Computer Animated Media Package	0	8	29	7	13.05	44	2.02

Table 3 shows the achievement test results of 44 students using two Technology-Enhanced Learning (TEL) tools based on their scores. The results indicate that the learning outcomes using Computer-Animated Media Package (CALA) differed from those of Ideogram. EXP I. had a mean score of 11.02 (standard deviation 3.17), while EXP II had a higher mean score of 13.05 (standard deviation 2.02).

Test of Hypothesis

H0: There is no significant different between the test scores of Ideogram as compared to Computer-Animated Media Package in perceiving cell biology concepts

Table 4: Paired t-test Scores between Ideogram (EXP.I) as compared to Computer-Animated Media Package (EXP.II)

	N	Mean	SD	R	t	df	Sig. (2-tailed)	Remark
EXP.I - EXP.II	44	-2.02	1.61	0.902	-8.352	43	.000	Significant

Table 5 shows that $r = 0.902$ indicating that there is significant relationship between the performance of students in EXP.I and EXP.II. The p-value for the paired t-test is greater than 0.05 $(p > 0.05)$ which resulted to the rejection of the null hypothesis and the result was significant. That, there is significant different between the test scores.

DISCUSSION

Results from table 1 indicates several key insights about the demographic and technological preferences of the participants regarding understanding cell biology concepts using Technology-Enhanced Learning (TEL) tools. The preference for the Computer-Animated Media Package suggests that students are looking for more immersive and visually engaging ways to learn complex scientific concepts. Ideogram, which likely offers more static or less engaging content compared to the Computer-Animated Media Package, may also not meet the dynamic learning needs required for this subject. This is inline with findings of Akinbadewa and Sofowora (2020) that "an additional explanation for this effect could be associated with the interesting activities students were engaged in while interacting with the packages. These activities include voice narrations, navigational structures, animations, evaluation questions, immediate feedback, and short videos. Ahmad (2010) explained that multimedia involves integrating various forms of digital media, such as text, images, audio, and video, into a unified, interactive application or presentation to communicate information effectively to an audience. Teachers should utilize multimedia to enhance and adapt the content of their material, making it more engaging and meaningful by incorporating different media elements.

Similarly, results from table 2 indicates that CALA was an effective approach for perceiving and teaching cell biology concepts. This finding is in agreement with the assertion of Mayer (2009) that using multimedia was more effective when it is interactive and under the control of the learner. Also, the results from table 3 shows the frequency of achievement test scores using two Technology-Enhanced Learning (TEL) tools. The results indicate that the learning outcomes using Computer-Animated Media Package differed from those of Ideogram. This findings corroborate with that of Akinbadewa and Sofowora (2020) which showed that multimedia instructional learning packages enhanced students' academic achievement in biology. Students in the experimental groups exposed to the multimedia instructional learning packages had higher achievement scores than those in the control group that was exposed to the conventional teaching method. This also accounts for the test of Hypothesis presented in table 4 which shows a significant difference between the test scores in EXP. I and II respectively. This aligns with the findings of Sangodoyin (2010), which demonstrate that treatment has a significant impact on students' performance in Biology. The use of computer animation was found to be effective in enhancing students' achievement. As a result, it is recommended that computer animation be adopted as a method for teaching Biology in Nigerian secondary schools.

CONCLUSION

From the discussions above, it was concluded that;

1. Computer-Animated Media Packages are among the most effective tools for Technology-Enhanced Learning (TEL), this shows the effectiveness of TEL tools in perceiving cell biology concept among students.
2. Students' academic outcomes varies when using Computer-Animated Media Packages compared to Ideograms. Thus, visual and interactive tools, like animated media packages, are advantageous in enhancing academic achievements of students.

RECOMMENDATION

Based on the above findings, the following recommendations were made;

1. Integrating technology-enhanced learning tools is essential for illustrating complex concepts like cell division, as it can offer personalized learning experiences in science courses.
2. Students should be encouraged to use educational platforms for collaborative peer learning, helping them identify areas for improvement.
3. Course lectures should promote the use of smartphones and computers for accessing online resources at students' convenience, enabling them to apply their knowledge through discussions and hands-on activities in class.
4. Educators and curriculum developers must understand the significance of incorporating interactive media into science education. Therefore, there is need for government to organize seminars and workshop on integrating TEL tools in education.
5. Management at the departmental, college, and institutional levels should provide affordable and accessible resources to ensure effective use of technology-enhanced learning tools.

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