

The use of computer simulations as a teaching method for improving learners' performance in learning the concepts of biology (plants and animal cells).

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Abstract

This study investigated the use of computer simulations as a teaching method for improving learners' performance in learning the concepts of plants and animal cells. This study consisted of 240 learners from Gs Musenyi, Gs Nyagihunika and Gs Rulindo located in Bugesera district Rwanda. Respondents were randomly put into treatment and control group. These groups were taught the same topic of plant and animal cells for two weeks. An experimental group was taught using iCell simulations and a control group was taught without simulations. Biology achievement test was administered to both groups of students to check performance variation. The learners' marks were examined using t-test and the results showed that treatment group performed better than control group. Also, the results showed the significant difference in marks obtained by both groups at the alpha of 0.05 as test statistic = -3.718, P-value=0.00<0.05. Hence, it has been proven that, using computer simulations in teaching and learning improves learners' performance.

Keywords: Computer simulation, control group, iCell simulations, treatment group, learners' performance and t-test.

Introduction

Information and communication technology today is playing a critical role in teaching and learning process especially in science education. Before high technology spread across educational scope, sciences were taught using traditional teaching approaches where the teacher dominated the class. The use of computer simulations for example, makes teaching and learning more interesting and learners gain practical skills (Ambelu & Gebregziabher, 2011). In order to achieve quality education, using computer simulations is an important teaching method especially in science since science by its nature involves practical aspects.

Over several years, Biology teachers faced the problem of handling students with poor performance level towards Biology. Then, computer simulation became an effective tool to supplement teaching to increase students' concentration level. The study conducted by Augustina & Morenike (2014) showed that teaching with the aid of technology was more effective than teaching using traditional approaches especially in science. Therefore, it is the responsibility of science educators to employ simulations in their teaching of science.

In particular, teaching using computer simulations improves learners' academic performance especially in science based subjects by adapting and applying science knowledge in real life situations (Murugesan, 2019). Computer simulation involves the utilization of computer to imitate operations of real world processes and situations happening in real life. Computer simulations facilitate science teaching and learning through enriched visualization and interactivity with active virtual reality of natural phenomena (De Jong & Van Joolingen, 1998). Computer

simulation involves predicting the results of an actual situation and their use improves academic attainment (Huppert et al., 2002).

Lack of computer simulations among Rwandan teachers, motivated this research in three selected secondary schools in Bugesera district. Hence, this study investigated use of computer simulations as a better teaching method for raising learners' performance in teaching and learning of biology in secondary schools. Learners' performance in sciences in Rwanda has been decreasing due to abstract and theoretical teaching of sciences that lack applications of science concepts in real situations. Teaching learners theoretically make learners lose motivation because they cannot connect the content to the real world (Josephine, 2016). It was shown that simulations increase teachers' and learners' potential of discovering more knowledge and how to apply it (Hursen & Asiksoy, 2015). Therefore, this study is an attempt to investigate if teaching plant and animal cells through the use of computer simulations can improve learners' understanding. Hence, this research on the use of computer simulations as a teaching method for improving learners' performance in learning the concepts of biology (plants and animal cells) will be useful for teachers and students. Having a clear view and experience of especially science teachers on the proper use of simulations will improve learners' understanding; they will try to do better which will lead to better study habit generally in science and particularly in biology. This study could encourage teachers to be aware of appropriate methods for the expansion of directions in teaching and learning biology. Moreover, it will also motivate school officers to help the teachers to upgrade their teaching strategies through provision of enough training courses. Furthermore, the findings of this study will serve as a guide for future researchers who will conduct similar studies on the subjects of interest.

By definition; teaching aids describe the resources teachers use to deliver instruction and improve students' attainment. Teaching aids facilitate educational process and are desired by learners comparing with teaching via traditional teaching methods (Jepkoech, 2002). Learners are more motivated to learn science particularly biology through observing and discovering methods instead of memorizing. This enables them to listen, recognize, and remember the content learnt more effectively. Therefore, more resources' accessibility raise the quality of acquiring knowledge and attentiveness about the subject taught (Fuller, 1986). It was shown that certain secondary teachers in Harare did not have enough materials to support them while teaching which caused learners fail to appreciate, apply and link knowledge they were taught to real life (Shumbo, 1993). Availability of teaching aids including computer simulation, is one of the most important variables related to learners' achievement (Rutten et al., 2012).

Computer simulation refers to a computer crossing point described using a greater point of contact enabling user to consider that he/she is really in the simulated situation (Hong, 2010). Utilization of computer simulations improves students' ability to explain learned content (Zacharia & Anderson, 2003). With Rwanda's Education policy all children have a right to learn. But having the right to education is not enough with effective education for all the

learners. Computer simulations are extremely appropriate for teaching and learning science. Therefore, instructional materials with strong effectiveness such as computer simulations must be taken into consideration by schools and education system (Kimutai, 1991). This was supported by Wekesa (1993) who showed that there is a strong connection between using modern teaching aids and students' achievement. This was also supported by Lawrence Ong et al. (2017) who confirmed that negative learning outcomes are indicators of lack of instructional materials as a fundamental requirement for good learners academic performance.

Rwanda's school laboratories and computers in schools are still very inadequate. Therefore, to achieve the education policy for all promise, advanced technology involving the use of computer simulations is paramount. Using computer simulations is one of the teaching methods used to eliminate practical limitations and improve students' performance especially in science (Nkemakolam et al., 2018). Nowadays computers have been used in education for numerous purposes and simulations become effective. Even if there is still a debate among scholars including Cuban (1997) about how technology is used in science subjects, computers have several benefits in Education (Lazarowitz & Huppert, 1993; Akpan & Andre, 1999).

Computer simulations enable learners to interact with the real world and carry out would be difficulty practices (Strauss & Kinzie, 1994). This is supported by Mengistu & Kahsay (2015) who showed that teaching using virtual simulations improves learners' understanding through providing a degree of reality that is unachievable when traditional teaching method is used. Therefore, when learners interact with computer simulations, they become highly motivated, understand different phenomena and control these in diverse situations. More so, learners develop cognitive abilities, struggle and study better inquiry regarded as a prerequisite in learning science and imitate real situations using simulations (National Science Education Standards, 1996).

Computer simulated practices are alternative teaching methods that can be used in the place of hands-on laboratory practices. While teaching and learning some concepts, it is possible to use computer simulated practices instead of hands-on laboratory practices and get the same results (Choi & Gennaro, 1987). Slotta (2002) summarized the roles of computer simulations by saying that they support science to become more accessible, improve critical thinking, and assist learners to learn on their own and teach themselves through developing independent learning as well.

Moreover, using computer simulations into the classroom become more effective due to the fact that they enable to develop learners' knowledge and empathy through making learners' complications easy and improving lecture demonstration (Friedler et al., 1992). Consequently, when teachers and learners use computer simulations, their attitudes in the direction of technology and sciences change positively. Therefore, this study investigated the

impacts of using particularly iCell simulations in teaching plant and animal cell concepts of biology on learners' understanding.

Objective

Mainly, this study aims at investigating the influences of using iCell simulations as a teaching method for raising learners' understanding of the plant and animal cell structures and functions. Specifically, this study intended to find out if there is any practical improvement in the learners' performance in plant and animal cell concepts when simulations are used; by comparing to the use of traditional teaching approach.

Hypothesis

The present study has the following hypothesis:

- There is a difference in performance (marks) of students taught using iCell simulations versus students taught using traditional teaching approach.

Methodology

Research design

This study used quantitative methodology for collecting and analyzing the data from participants. Therefore, this research involved quasi-experimental design where quantitative research was adopted. Through this design, the researchers used the intact groups due to the availability of participants (Creswell , 2013). The dependent variable is the learners' performance and independent variable is the use of computer simulations. Quantitative data was collected through biology achievement test administered to students under the study. Data collection tool was administered within the three selected schools and study descriptions were obtained from respondents within these selected schools. Data presentation and analysis required the use of statistical package for social sciences and tables.

Population, sample size and sampling procedure

In this study, the population was 600 senior one (S1) students in 12 Years Basic Education (YBE) schools of Bugesera district. The motivation for choosing S1 students is due to the abstractness of some S1 biology topics that would have been taught under practical approach using computer simulation. The sample size consisted of 240 students at Gs (Groupe Scholaire) Musenyi, Gs Nyagihunika and Gs Rulindo. Those schools were selected because these schools are close to each other and have adequate ICT facilities and equipment to make the research rather cost-effective. To get the sample size, Guilford and Fruchter formula was used.

$$n = \frac{N}{1 + \mu^2 N}$$

Where n is a sample size, N is the population size= 600 and μ is alpha = 0.05

$$\text{Then, } n = \frac{600}{1+0.05^2 600} = 240$$

In this study, the researchers used purposive sampling; depending on what they wanted to achieve and to know (Palys, 2008). Hence, 3 schools with 12 YBE located in Bugesera district were deliberately selected since these schools have IT facilities to be used under this study.

Research Instrument

Biology Achievement Test was administered to students; thus helped the researchers to obtain desired quantitative data that was used in the study. In this method, one class in each of three selected schools was used as an experimental group where it was exposed to iCell simulations; and other class as a control group where it was exposed to traditional teaching method without the aid of simulations. The researchers prepared the same achievement test for both groups to check if there was any difference in their performance or not.

Data collection process

To find out the impact of using iCell simulations as a teaching method on learners' performance in biology, it involved the following process: Biology teachers in the three selected schools who had to teach the experimental group were trained on how to use computer simulations for two weeks. On the side of students participating in the investigation, for every selected school; two classes were used where one class acted as a treatment group and another as a control group. Therefore, learners of experimental group were taught with the help of iCell simulations whereas traditional teaching method was adopted for students in a control group on the topic of plant and animal cells. Both control and experimental groups were given a biology achievement test after running instruction (iCell simulations) to find out if there is any difference between these two groups. The test consisted of questions on plant and animal cells including the likert scale and open-ended questions.

Data analysis process

Data gathered from tests were analyzed using statistical package for social sciences (SPSS) where frequencies and percentages were calculated. In this research, tabulation method was used, thus helped the researcher to present data using tables and analyzes them. Again, mean, standards deviation, standard Error of the mean, and t-test for determining students' performance were calculated through SPSS.

Data collected from Biology Achievement Test were analyzed using statistical package for social sciences (SPSS) and statistical techniques included tables and independent samples t-test. The t-test was calculated using the significance level of 0.05 and such t-test was also conducted to examine the difference in teaching using iCell simulations and traditional teaching method to determine effectiveness of using simulations.

Results and discussions

This chapter presents the results presentation, interpretation and analysis of the Biology Achievement test administered to the participants with intention to measure their knowledge and performance on the topic of plant and animal cells through iCell simulations.

Table 1: The results of the Biology Achievement test administered to the participants (control group and experimental group)

Groups	N	Mean	Std. Deviation	Std. Error Mean
Marks Control group	120	31.7792	15.46096	1.41139
Experimental group	120	47.9000	17.05325	1.55674

As indicated in table 1, the average distribution of the test results gained by both control group and experimental group are statistically different and significant. As per the Mean, Std. Deviation, and Std. Error Mean for both groups in table 1, the experimental group demonstrated higher knowledge and performance on plant and animal cell compared to a control group. Therefore, this statistical difference is indicative of the impact of using computer simulation in teaching biology and animal cells.

Table 2: independent sample t-test results obtained by control group (CG) and experimental group (EG) of students

Quantity type	CG vs. EG
Test statistic (t)	-7.672
P-value	0.00
Degree of freedom	238
Significance level (alpha)	0.05
Mean difference	-16.12
Significance consideration	Significant

Based on the results in table2 above t (test statistic) = -7.672, P -value=0.00<0.05. Therefore, there is a significant difference in marks obtained by control group and experimental group in biology achievement test at the alpha level of 0.05.

Furthermore, the results of this study have shown that, there is a significant positive impact in teaching plant and animal cell concepts of biology using iCell simulations as a teaching method. It is evident that, teaching biology using computer simulations improved learners' understanding and performance in learning plant and animal cell structures and functions at GS MUSENYI, GS NYAGIHUNIKA and GS RULINDO in BUGESERA District.

This runs through REB's advice to use technology in advancing teaching and learning. REB stated that, the educational success is mostly influenced by the involvement of technology. Therefore, teachers are encouraged to use modern teaching aids including computer simulations in their daily teaching in order to improve learners' understanding and performance.

In this study, the significant difference between the control group and experimental group performance is a clear indicator of the strong and impactful advantage of using technology especially simulations in teaching and learning to improve learners' performance than traditional teaching method. In their study too, Jane & Science (2017), found out that learners taught using computer-based simulations performed better than those who were taught using traditional teaching method. They ascertained that, computer-based simulations teaching approach is more effective than traditional teaching approaches.

Simulations enable learners to retain the learnt content more effectively and lead to easy application of the knowledge. Computer simulations are more effective for learners because they enable learners to learn through visualization and help them to change abstract content into concrete content that can be easily applied and linked to real-life situations (Olalekan, 2016). Indeed, simulations enable learners to actively participate in their lessons and improve their knowledge and transfer what they have been taught to the real-life situations more easily. According to Onche (2014) lack of access to modern teaching aids is the main source of poor performance of the learners. When human senses are involved and stimulated the learning process becomes more effective and brings positive feedback. Learners are more motivated to learn through doing and using their senses including seeing and hearing. Learning through hearing and seeing enable learners to retain what they have learnt in easy manner (Saunders 1994). Through using simulations, visual sense is stimulated which enable learners to gather and process information from the surrounding environment and change them into meaningful thoughts.

Conclusion

This study has re-affirmed the fact that, using computer simulations in teaching help learners turn the abstract content into concrete knowledge and are able to link knowledge to real-life situation. The results of the present study agree with the hypothesis showing that there is a difference in performance between students taught using iCell simulations and those taught using traditional teaching approach.

Therefore, computer simulations should be a priority in teaching and learning as alternative way of conducting laboratory experiments especially for natural science subjects. Learning sciences including biology using traditional methods has for so long affected learners' understanding sciences.

The use of computer simulations in this study has resulted into significant positive impacts on learners and contributed on their performance in biology test. It is evident that, the use of computer simulations enables learners to turn abstract and concepts into real-life situation and improves their performance.

Also, this study demonstrated that computer simulations have positive impacts on learners' performance in animal and plant cell concepts. Computer simulations are also motivational and interactive for students' learning as well. Technological teaching aids are vital elements for an effective pedagogy. Furthermore, technological teaching aids enhance learners' motivation, attention, retention and academic performance. Using simulations is therefore, an alternative teaching methods that can improve learners' performance.

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