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# Effect of Computer Simulation on JHS 2 Students' Performance in Integrated Science

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**Abstract:** This study explored the use of computer simulation to improve upon teaching and learning of Integrated Science among all JHS 2 students of University Practice North Campus JHS, Winneba, Effutu Municipal of Central Region in Ghana. The objective was to assess students' performance by using computer simulation to teach some selected topics in integrated science. A sample size of eighty-eight (88) students of the school was used for the study. It was an Action Research where a quasi-experimental design was adopted. Five class tests and an opinionnaire were used for data collection. Descriptive statistics was used to analyze data. The results revealed that students understood the selected topics and performed better when they were taught lessons using computer simulations. The implication for teaching and learning was stated that computer simulation support system made science classroom more realistic. The study recommended that Integrated Science teachers should be equipped with the ICT skills to enable them to use computer simulations to teach more topics in Integrated Science.

**Keywords:** Computer simulation, traditional method, ICT, critical thinking, communication skills, manipulating skills, listening skills and opinionnaire.

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## INTRODUCTION

Integration of Information and Communication Technology (ICT) in education has been an important concern in many countries, most especially, developing countries as it brings about development in those countries. Ghana as a developing country is also making frantic efforts to make ICT a core subject in the school curriculum to improve teaching and learning at all levels of education and to equip students with the necessary skills in ICT for national development. The inclusion of ICT in the school curriculum is also geared towards the improvement of the teaching and learning of science at all levels of education. This was evident in the year 1995 when the Ministry of Education and the Ghana Education Service established the Science Resource Center Projects in one hundred and ten (110) Senior Secondary Schools spread throughout the country (GES, 2004). These centers were well stocked with equipment and apparatus in order to enhance the teaching and learning of science in these schools as well as satellite schools around them. Through empowering science teachers (In-service Training), the syllabus for teaching science at all levels has undergone so many reviews in order to improve upon its teaching and learning of contents and to motivate students to learn science.

The integration of ICT into education has been assumed as the potential of the new technological tools to revolutionize an outmoded educational system. Anderson and Weert (2002) attested to the fact that ICT plays a critical role in improving educational systems in many countries. In these countries, stakeholders in educational policy redesigned and reconstructed their educational systems based on the new educational paradigms so that both teachers and students develop the necessary knowledge and skills in this digital age. Hence, most countries around the world are focusing on approaches to integrate ICT in teaching and learning to improve on the quality of education (Anderson & Weert, 2002).

According to Acquah (2013), in Ghana, students' dismal performances at both basic and secondary levels in science have been a great source of concern to parents and stakeholders in education. Many factors like general lack of interest in the subject by both teachers and students and inadequate teacher preparation (Djangmah, 2010; Osei- Kwabena, 2011) and inappropriate teaching methods (Little, 2010) among others, have been blamed for students' poor performance in basic school science (Ogunmade, 2005; Ampiah, 2010).

There are so many methods of teaching science in schools. There is the traditional method which involves the use of models, charts, diagrams, and handling of objects. According to Little (2010), the traditional approach to teaching subjects especially science is not motivational to many students which leads to their development of negative attitudes toward science. There is also the technological method which includes computer simulations. Simulation is the use of a powerful tool, the computer, to emulate or replicate an object in a real or imagined world. Many potential benefits have been claimed for the use of computer simulation in teaching science. It is against this background that; the researcher deems it important to find out how the use of computer simulation can help to improve students' performance in learning selected topics in integrated science in University Practice North Campus Junior High School at the Effutu Municipality. This was based on the following research question and a hypothesis.

**Research question:**

How will the use of computer simulation influence JHS 2 students' performance in selected topics in integrated Science?

**Null hypothesis:**

There is no significant difference between JHS 2 students' performance in science when they are taught lessons using computer simulation and traditional methods.

**Methodology**

The study adopted pre-test and post-test strategies as enshrined in an action research design to collect the data. The focus was on determining the effects of computer simulation on Junior High School form two students' performance in selected topics in integrated science in the school.

According to Cohen, Manion and Morrison (2008), action research is very popular in the field of education because there is always room for improvement when it comes to teaching and educating others. There are all types of methods of teaching in the classroom, but action research works very well because the cycle offers opportunities for continued reflection. In all professional fields, the goal of action research is to improve processes. Action research is also beneficial in areas of teaching practice that need to be explored or settings in which continued improvement is the focus especially, in teaching and learning. These authors further posit that action research is 'learning by doing' in which a group of people identify a problem, do something to resolve it, see how successful their efforts were, and if not satisfied, try again. While this is the essence of the approach, there are other key attributes of action research that differentiate it from common problem-solving activities that we all engage in every day. Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. That is, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of the researcher and client and that it stresses the importance of co-learning as a primary aspect of the research process.

The accessible population was all JHS 2 students in the University of Education, Winneba, North Campus Practice School located in Effutu Municipal of the Central Region. The sample size was made up of all the JHS 2 students in the school. A total of 88 students were involved in the study. This comprised 29 students each from JHS 2A and 2B, and 30 from 2C. The sampling method for the study was a convenient sampling technique. The convenient sampling technique was used because the researcher teaches science in form two classes in the school and the topics under study are also found in the form two syllabus. So conveniently, it was appropriate to involve the students in the study. According to Fraenkel and Wallen (2003), convenience sample is a group of individuals who (conveniently) are available for study. A Pre-test and Post-test and opinionnaire were used to collect data. A Pre-test was conducted for the students in the selected topics after they were taught using the traditional method. A Post-test was later conducted for the same students at the end of the implementation of the intervention based on those selected topics from the Integrated Science Syllabus taught using the computer simulations. Students were also asked to write their opinions at the end of the computer simulation lessons. A Post-test was given to the students. Since the research was aimed at the use of computer simulations and their influence on students' performance in the learning process in Integrated Science, it was appropriate to use a pre-test, post-test and opinionnaire for data collection.

The data collection procedure was divided into four phases. These were pre-intervention, intervention, post-intervention phase and students wrote their opinions after the simulation lessons.

**Pre-intervention phase:** The researcher informed the head teacher about the research work she wanted to carry out in the school in order to solicit his cooperation and assistance. Permission was therefore asked from him to use the school laptop computers for the study. Downloaded simulation videos were installed on the school laptops (20 in number) and were pilot- tested on seventy (70) JHS 1 students in the school. This was done to find out the effectiveness of the instruments.

**Intervention phase:** This was where students were given a pre-test to answer based on what they have learnt when they were taught using the traditional method. Later, simulation videos were used to teach students. The teaching lasted for eight weeks. The simulation videos were carefully selected based on the selected topics from the JHS 2 Integrated Science Syllabus. Some science concepts were identified from the simulation videos and the researcher discussed them with the students. At that point, students were asked to pause the simulation videos for discussion after which they continued to play it. Students also asked questions to the researcher when necessary. The researcher monitored students' activities and intervened as and when required.

**Implementation of the computer simulation video:** This involved five activities. The activities were explained as follows:

***Activity 1*: *Introduction***

Students' relevant previous knowledge was reviewed by the researcher through questions and answers. This was done in order to evaluate the level of support the students will need as they interact with the new lesson for easy assimilation of the new material.

***Activity 2: Conduction of the simulation lessons***

Students were put into groups of two (2) by the researcher. The school laptop computers containing the simulation video files were distributed to the students by the researcher. Students were guided on how to open the appropriate video files. Students then watched the simulation videos and noted some key points down into their notebooks. However, at a point in time the researcher asked students to pause the simulation videos for some science concepts like diffusion of food nutrients in the ileum through the villi into the bloodstreams, movement of water and mineral salt from the soil through the xylem tissues to the leafs (osmosis and diffusion respectively) and pressure with which the heart pumped blood to be discussed. Students were also allowed to ask questions for clarification of points when necessary.

***Activity 3: Monitoring and intervening***

While the students watched the simulation videos, the researcher moved around to assist them when necessary. Some of the students asked the researcher some questions for clarification based on the simulation videos. At a point in time, the researcher also asked students questions based on the simulation videos just to put students on track and also to stimulate them on the learning tasks. The researcher moved around to assist groups and individuals as well when the need arose.

***Activity 4: Evaluation***

Class tests were used to evaluate students based on the tasks. In order to evaluate students' understanding of some science concepts, questions were administered to them to answer. The researcher specifically set these questions to test students' understanding of some science concepts involved in the study. Another set of questions were also given to students to answer. This was to assess students' understanding for that matter their performance. Each student answered the questions independently. They were not allowed to help each other during the writing of the class test.

***Activity 5: Marking and scoring***

Each student's class test collected was marked and scored. These scores were put together for each student.

***Activity 6: Provision of feedback***

Students were provided with feedback on the class test taken. This was done to correct mistakes made by students and also to motivate them to learn tasks with seriousness.

**Post-intervention Test:** Data collection lasted for eight weeks. At the end of each week, a post-test was administered to students. The post-tests were based on digestive system, circulatory system, photosynthesis and respiratory system. Each test was made up of three sections. Section A consisted of multiple-choice items. Section B was some diagrams for students to label and some essay-type items and Section C was only essay-type items. The test items were administered in their respective classrooms. The students' scripts were marked and scored. This was to assess the effectiveness of the simulation lesson on students' academic performance.

**Validity of the instrument**

The goal of a good research is to have results that are reliable and valid (Creswell, 2005). Validity is concerned with whether the findings are really about what they appear to be about (Robson, 2003). Leedy and Ormrod ( 2002) noted that validity remains important within any research that needs to ensure that people's lives, experiences, and views are represented accurately. To determine this, test items and an opinionnaire were

submitted to the lecturers in the science education department from the University of Education, Winneba for expert judgment. Further corrections were made based on their suggestions. The test items were also subjected to item difficulty index analysis after the pilot test was conducted at University Practice Junior High School (North-Campus), Winneba on JHS 1 students in the Effutu Municipality in the Central Region of Ghana. The review made by the lecturers and the pilot testing helped to review some items and modify the instruments before administering them.

**Reliability of the instrument**

Reliability according to Cohen, Manion and Morrison (2008), means that scores from an instrument are stable and consistent; scores should nearly be the same when researchers administer the instrument multiple times and also scores need to be consistent. To ensure reliability, the items in the instruments were designed to cover the key areas raised in the research questions. Item difficulty Index was used to determine the difficulty level of test items. The item difficulty index (P) is determined by calculating the proportion of examinees that, answer the item correctly (Fossey, 2013). According to Fossey (2013), the item difficulty index (P) has a range of 0.00 to 1.00. If no one answers the item correctly, the P value would be 0.00. An item that everyone answers correctly would have a P value of 1.00. This means, the higher the P value, the easier the item and the lower the P value, the more difficulty the items. With regard to this study, the internal consistencies were determined by calculating the item difficult index (P) for each test item used in both the pre-test and the post-test. Each test item used yielded a P value between 0.08 and 1.00. This value indicated that the items were easy for students to answer.

**Data Collection Instruments**

Pre-test items, Post-test items and an opinionnaire were used for data collection from the students' group.

**Pre-test**: Teacher made test items based on the selected topics were administered to the students when they were taught those selected topics using the traditional method. These test items contained 25 test items each based on the selected topics.

**Post-test**: Teacher made test based on the simulation videos was administered to the students at post intervention stage. This was done to assess students' academic achievements and the effectiveness of the simulation lessons after successful treatment of the selected topics. The test was made up of three sections. Section A consisted of multiple-choice items; section B required students to label some diagrams and also answer some essay-type items; and section C contained some essay-type items only. The scripts for each topic was marked and scored and immediate feedback was given to the students. The data gathered were analyzed and used in responding to the research question and the research hypothesis.

**Opinionnaire**: All the students (sample) were asked to write their opinions about the simulation lessons at the end of the implementation of the intervention. According to Cohen, Manion and Morrison (2008), Opinion is what a person says on certain aspects of the issue under consideration. It is an outward expression of an attitude held by an individual. They stated that opinionnaires are generally of two types. These are the closed or pre-categorized type and the open or free response type. This author further posits that it is recommended that the open-ended form of opinionnaire should be adopted for most uses unless a very large of respondents is involved. The open-ended opinionnaire was therefore adopted for the study. Students were required to write their opinions at the end of the simulation lesson in order to assess the effectiveness of the lessons on academic achievements.

**Data Analysis Procedure**

The scores gathered from the pre-test and post-interventional test exercises were processed with Microsoft Excel, 2010 version. The performances of the students were compared using t-test analysis. The aim of using the t-test was to determine whether there was a significant difference between the mean scores of students when they were taught those selected topics using traditional method and computer simulation. Again, to determine whether the use of computer simulation in teaching selected topics in integrated science to students had an influence on their performance. The results obtained were used as evidences in supporting implications made from the study. Moreover, to determine students' opinions (Opinionnaire) at the end of the simulation lessons, students' opinions written at the end of the simulation lessons were categorized under the following themes which were related to the research question raised in the study. These are: Students understanding of simulation lessons in selected topics in Integrated Science and their performance at the end of the simulation lessons.

**Results**

The statistical analysis that were used for making deductions and testing hypothesis as well as interpreting the results that provide responses to the research questions have all being presented in this section.

**Pre-test and post-test scores of students**

The mean scores and variance of the pre-test conducted for students before introducing the treatment and the mean scores and variance of the post-test conducted after introducing the treatment were compared using descriptive statistics displayed in Table 1.

**Table 1:** Descriptive Statistics of the Pre-Interventional Scores and Post-Interventional Scores of Students.
t-Test: Paired Two Sample for Means

| | *Pre-test* | *Post-test* |
|---|---|---|
| Mean | 40 | 71.55681818 |
| Variance | 10.48275862 | 99.95075758 |
| Observations | 88 | 88 |
| Pearson Correlation | -0.04580782 | |
| Hypothesized Mean Difference | 0 | |
| df | 87 | |
| t Stat | -27.7990444 | |
| P(T<=t) one-tail | 2.37469E-45 | |
| t Critical one-tail | 1.662557349 | |

**Research question**

The research question formulated to guide the study was: "To what extent does the use of computer simulations influence JHS 2 students' performance in selected topics in integrated science?"

In order to respond to the research question, the pre-interventional score and the post- interventional score of students were analyzed as presented in Table 1. The mean scores were forty (40) and seventy-two (72) for the pre-test and the post-test respectively as indicated in Table 1. Again, the information presented in Table 1 indicated that the variance for the pre-test was eleven (11) and the post-test was (100). Since the mean score as well as the variance for the pre-test is lower than that of the mean score and variance of the post-test, there is an indication that computer simulation had a positive influence on JHS 2 students' performance in selected topics in integrated science.

**Null Hypothesis ($H_o$):** The stated null hypothesis is: "There is no significant difference between JHS 2 students' performance in science when they are taught lessons using computer simulation and traditional method".

In order to respond to the hypothesis, from Table 1, the calculated t-test was 27.8 and the tabulated t-test 1.66. Since the calculated t-test is greater than the tabulated t-test then we reject the null hypothesis ($H_o$) and this means there is a significant difference between the pre-test scores and the post-test scores of students. This means, there is a significance difference between the academic performances of students when they received instructions on selected topics in integrated science through computer simulation and when they received instruction on the concepts through the traditional method approach.

**Discussions**

The scores obtained from the post-interventional test showed that, computer simulation had positive influence on JHS 2 students' performance in selected topics in integrated science**.** For instance, in Table 1, the mean score of the post-interventional exercise for the subjects was 71.6 whereas that of pre-interventional exercise for the subjects was 40. These two mean score values suggest a higher performance among subjects when they were taught lessons using computer simulations. The mean score value of the post-interventional exercise (71.6) is almost two times (40), which is the mean score for the pre-interventional exercise of the group.

Also, the variance for the post-test of the subject was 99.9 but the variance for that of the pretest of the subject was 10.5 as indicated in Table 1. This implies that, the interventional strategy for the subjects was more effective than the traditional strategy used for the subjects.

Again, the scores obtained from Table 1 showed a significant difference between the performance of students when they were taught lessons using computer simulation and when they were also taught using the traditional strategy. For instance, in Table 1, the calculated t-test was 27.8 whereas the tabulated t-test was 1.66. These values suggested that students performed better when they were taught lessons using computer simulation than when they are taught using the

traditional method. This increase in the academic performance of students showed that computer simulation is effective for teaching and learning of some topics in Integrated Science.

This result is consistent with the findings of Gokhale (2011), who stated that effective integration of computer simulation into traditional lecture-lab activities enhances the academic performance of the students.

Moreover, the following authors' ideas also seem to support the findings of this study. Boblike and Lunneta (2010) found that the computer simulation instruction groups had significantly better achievement scores than the control groups receiving traditional instruction in high school physics.

## Conclusion

This study concluded that computer simulations had positive effects on students by enhancing their understanding of concepts in Integrated Science. Most especially concepts which were abstract in nature. Some of these concepts were digestive system in human, circulatory system in human, photosynthesis and respiratory system in human. Students also supported this idea by stating that, they understood these concepts better when they were taught lessons using computer simulations. The various findings on the use of computer simulations in the teaching and learning of those abstract concepts in Integrated Science cannot be overlooked since understanding of concepts in their natural forms and enhancement of students' performances are core issues in motivating students in science subjects.

## Recommendations

Based on the findings of the study, the following recommendations were made:

- In-service training programmes should be organized for integrated science teachers in University Practice North Campus Junior High School to equip them with the necessary skills that would enable them to use the computer and software to teach concepts in integrated science.
- Since computer simulation influences students' performance in learning and understanding concepts in Integrated Science, teachers in the school system need to be equipped with Information Communication and Technology (ICT) skills.

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