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Effects of Computer Assisted Simulation Instruction on Secondary School Students' Retention in Chemistry in Awka Education Zone in Anambra State

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Abstract: This study examined the effect of computer assisted simulation instruction on senior secondary school students' retention in Chemistry in Awka Education Zone of Anambra State. Two research questions and two null hypotheses guided the study at 0.05 level of significance. Quasi-experimental design was adopted, with a population of 4,755 SS1 Chemistry students. A sample size of 160 SS1 students consisting of 82 males and 78 females were selected using multi-stage sampling techniques. Chemistry Achievement Test (CAT) consisted of 50 test items was used for data collection. The instrument was subjected to face and content validation. The reliability of the instrument was carried out by the researcher with students who were not part of the study. Reliability co-efficient of 0.76 was obtained for CAT using Kuder-Richardson (KR-20) formula. The data collected were analyzed using mean, standard deviations and analysis of covariance (ANCOVA). Results showed that students taught Chemistry using computer assisted simulation instruction performed better than those taught using lecture method. Findings also showed no significant difference in the performance of male and female students' retention in Chemistry. Based on the findings it was recommended that computer assisted simulation instruction (CASI) be used in teaching Chemistry and other subjects.

Keyword: Computer Assisted Simulation, Retention, Chemistry, Gender

INTRODUCTION

Chemistry remains one of the core science subjects studied in secondary schools due to its central role in technological advancement and national development. Chemistry is a branch of science which deals with the study of nature, composition and properties of matter as well as the changes matter undergoes (Agbasi and Okeke, 2020). Ekundayo (2022) opined that Chemistry is rapidly expanding as it occupies a central position in the world of science, being a gateway to professions like medicine, pharmacy, and many other science-related professions. Its application immensely improves the quality of life in the area of health, teaching, and agriculture among others.

Chemistry as one of the core science discipline serves as a catalyst for interdisciplinary integration and fostering scientific literacy among learners. At the senior secondary school level, Chemistry is integrated within the curriculum to promote cognitive development, enhance learners' problem-solving abilities, and equip students with scientific competencies that enable them to function effectively within their immediate environment. The subject is widely recognized and valued not only by students but also by individuals who seek to expand their understanding of chemical phenomena and their applications to daily life.

Despite the importance of chemistry, the academic achievement of students in Chemistry in external examinations such as West Africa Senior Secondary Certificate Examination (WASSCE) and National Examination Council (NECO) have remained unsatisfactory. This is evidenced in the academic achievement in West Africa Examination Council (WAEC) Analysis from (2019-2023). In 2019, for aggregate of A1 -C6, a percentage pass of 55.60 was recorded, 57.74% in 2020, 60.68% in 2021, 59.42% in 2022, 61.98% in 2023. The performance of students in Chemistry over these years is fluctuating slightly above average and inconsistent. Thus, these does not argue well with the technological breakthrough desired by the nation as failure in Chemistry is a fall out of science career. Researchers such as Obikezie et al. (2021), attributed this unsatisfactory performance of students in Chemistry to several factors such as inadequate provision of laboratory infrastructure, poor laboratory facilities, use of inappropriate teaching methods among others.

Teaching methods according to Nwuba and Osuafor (2021) are the techniques employed by the teacher to communicate to the students in the classroom to achieve the stated instructional objectives. Teaching methods used by teachers could challenge students to work at a higher intellectual level that would improve their cognitive and psychomotor achievement. Knowledge gained can become worthless if it is not retained so as to be useful in future. Teaching methods are grouped into two: teacher centered and students centered.

According to Treve (2024) Teacher centered approach involves all the teaching methods that the teacher dominates in the lesson procedure and takes the lead in coordinating the classroom in regards to what to be done. Teacher centered approach like lecture method stresses more on transmission of knowledge in a manner that emphasizes memorization of concepts. The shortcoming of teacher centered approach resulted to the persistent search for effective teaching methods that would be student oriented.

Samuel (2017) opined that students centered approach include all teaching methods in which the teacher is not seen as a decision maker and problem solver in the classroom but rather sees the teacher as a guide, facilitator, mentor, coach, or consultant in the teaching and learning process. In view of the relevance of the students' centered approach (innovative approach) many researchers' such as Samuel (2017) and Ekundayo (2022) recommended a shift from the teacher centered approach of teaching Chemistry to students' centered approach like computer assisted simulation instruction among others in order to tackle the poor achievement of students in Chemistry. Thus, this study examined the use of computer assisted simulation in teaching Chemistry.

Computer assisted simulation instruction (CASI) refers to the use of computer as a teaching and learning tool. Nwoye (2019) defined CASI as an interactive instructional technique in which a computer is used to present instruction, monitor learning, and select additional instructional material in accordance with individual students' needs. It is a new teaching and learning strategy in which the topics to be taught is carefully planned, written, and programmed in a computer which could be run at the same time in several computer units with students at the computer terminal. It is an electronic form of education which allows the learner in a friendly learning interaction with the computer to present and enjoy programmed learning activity. CASI involves the teacher projecting and explaining the planned instructions in form of graphics, text, audio and visual files. At the end of each topic of instruction, the simulation activity related to the concept(s) taught will be played to enhance

internalization and meaningful learning. Students are meant to attempt the evaluation questions that follow before moving to the next topic. On the other hand, CASI will be readily available for the learner's use during the lessons for this study and after the study the package will be available to students to learn at their own convenient and pace.

Low academic self-concept in Chemistry is overcome when many difficult concepts are made clearer through the use of CASI (Samuel and Okonkwo (2020)). Thus, the use of CASI in teaching and learning of Chemistry helps the students understand the concepts taught thereby improving their performance in the subject.

When appropriate instructional method is employed in teaching and learning process it enhances students' academic achievement, which could in turn make them to retain more of the concepts taught.

Retention is simply the ability to remember what has been learnt. It is the ability to retain the knowledge of what is learnt and to be able to recall it when it is required. Okereke and Okigbo (2020) defined retention as the ability to absorb, hold or keep in memory what has been learnt and hence, remember to utilize the already acquired knowledge and skills over an extended period of time. Hence, retention simply means having learnt information stored in the long-term memory in such a way that it can be easily retrieved after a stipulated period of time. In other words when appropriate teaching method is employed in teaching and learning process students' achievement is enhanced and as well they remember the concepts taught.

Gender is an essential variable in this study. Gender is a social construct that distinguishes males from females. Some studies report gender differences in achievement in favor of female students (Amadi & Okeke, 2019), others show no significant differences (Agbasi & Okeke, 2020; Joshua & Okoli, 2019). This inconsistency highlights the need for further investigation into whether innovative methods such as CASI have gender-neutral effects on students' performance. This study, therefore, investigated the effect of computer assisted simulation instruction on secondary school students' retention in Chemistry in Awka Education Zone, Anambra State.

1. Statement of the problem

This study was motivated by the poor performance of students in Chemistry. Despite the importance of Chemistry in technological and scientific advancement, students' persistent low achievement in both internal and external examinations remains a serious concern for stakeholders in education. WAEC analysis from 2019 to 2023 reveal inconsistent achievement in Chemistry, with significant implications for the nation's economic, social, and technological growth. Failure in Chemistry limits the pool of potential scientific manpower and contributes to dropout rates in science related careers. From Chief Examiner's Report on Chemistry (2023), students showed weak points in chemical bonding. Poor understanding of these concepts, which are fundamental to understanding chemistry concepts is a serious issue. Researchers have attributed this poor performance largely to the abstract nature of these topics and the reliance on lecture method of teaching. The lecture method encourages passive learning and restricts student engagement, thereby weakening comprehension and retention. The problem of this study if to put into question is: To what extent can computer assisted simulation enhance students retention in Chemistry?. In other words the study wished to examine the effect of computer assisted simulation instruction on secondary school students retention in Chemistry in Awka Education Zone, Anambra State.

2. Purpose of the Study

The purpose of the study is to determine the effect of computer assisted simulation instruction on secondary school students' retention in Chemistry in Awka Education Zone, Anambra State. Specifically, the study determined the difference in:

1. mean retention scores of students taught Chemistry using computer assisted simulation approach and those taught with lecture method;
2. mean retention scores of male and female students taught Chemistry using computer assisted simulation approach

3. Research Questions

The following research questions guided the study.

1. What are the mean retention scores of students taught Chemistry using computer assisted simulation instruction and those taught using lecture method?
2. What are the mean retention scores of male and female students taught Chemistry using computer assisted simulation instruction?

4. Hypotheses

The following null hypotheses were formulated to guide the study at 0.05 level of significance. ($p<0.05$)

1. There is no significant difference in the mean retention scores of students taught Chemistry using computer assisted simulation instruction and those taught using lecture methods.
2. There is no significant difference in the mean retention score of male and female students taught Chemistry using computer assisted simulation instruction

METHOD

The population of the study comprised all the 4755 (2182 males and 2573 females) senior secondary one (SS1) Chemistry students in co-educational secondary schools in Awka Education Zone of Anambra State. (Post Primary School Service Commission Statistics Division Awka, 2022). Co-education schools were used for the study because it is easier to ensure a balanced condition for gender intact groups. SS1 students were used because the topics selected for the study is part of SS1 scheme of work and also form part of the basic foundation for learning other concepts in Chemistry in secondary schools. The sample size for the study was 160 SS1 Chemistry students. Simple random sampling technique was used to select the two local government areas out of the five local government areas in Awka Education Zone for the study. Four schools were selected from the co-educational secondary schools, two schools from each of the two local government areas sampled were used to carry out the study. Total of four intact classes of SS1 Chemistry classes were used for the study. With a flip of coin, two schools were taught Chemistry using computer assisted simulation instruction and the other two secondary school were taught Chemistry using lecture method. Total of 83 males students and 77 females students constituted the sample size.

The instrument for data collection was Chemistry Achievement Test (CAT). The CAT was used for both achievement and retention tests. The reliability obtained for the CAT had a coefficient of .76. The instrument was validated by 3 lecturers. Mean and standard deviation were used to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

RESULTS AND DISCUSSION

Research Question. 1

What are the mean retention scores of students Taught Chemistry using computer assisted simulation approach and those Taught using lecture method?

Table 1: Retention test Mean and Standard Deviation of Retention Scores of Chemistry Students Taught with Computer Assisted Simulation Instruction and those Taught with Lecture Method.

	Retention Test		
Groups	Mean	SD	Mean Differences
CASI	33.69	4.672	16.74
LM	16.95	7.209	

Research Question. 2

What is the mean retention score of male and female students taught Chemistry using computer assisted simulation instruction?

Table 2: Retention test Mean and Standard Deviation of Male and Female students' retention Scores using the Computer Assisted Simulation Instruction

	Retention Test		
Gender	Mean	SD	Mean Difference
Male	34.05	5.236	0.77
Female	33.28	3.947	

The result in table 4 showed that male students taught Chemistry using computer assisted simulation approach had mean score of 34.05 and standard deviation of 5.24 while female students taught using computer assisted simulation instruction had a mean of 33.28 and standard deviation score of 3.95. Male students taught using computer assisted simulation had a higher mean score than female students taught using computer assisted simulation instruction. This implies that computer assisted simulation method enhanced male students' retentive ability in Chemistry more than their female counterpart.

Hypothesis. 1

There is no significant difference in the mean retention scores of students taught Chemistry using computer assisted simulation instruction and those taught with lecture method.

Table 3: The ANCOVA Results of Retention Scores of Students Taught Chemistry Using Computer Assisted Simulation Instruction and Those Taught Using Conventional Lecture Method.

Source	Type III Sum of Square	df	Mean Square	F	Sig
Intercept	170048.06	1	170048.064	4533.199	.000
TEACHING METH	12142.214	1	12142.214	323.691	.000
Error	5926.850	158	37.512		

*Significant

The results showed that computer assisted simulation instruction had a significant difference in the mean retention scores of students taught Chemistry using lecture method and those taught Chemistry using computer assisted simulation instruction. The teaching method has p-value of < 0.05, thus it showed that there was significant difference. The null hypotheses that stated that there is no significant difference in the mean retention scores of students taught Chemistry using computer assisted simulation instruction is rejected. Since the mean retention scores of students taught Chemistry using computer assisted simulation instruction is higher than the mean retention scores of students taught Chemistry using lecture method, then computer assisted simulation enhanced students' retention in Chemistry.

Hypothesis. 2

There is no significant difference in the mean retention scores of male and female students taught Chemistry using computer assisted simulation instruction.

Table 4: The ANCOVA Results of Mean Retention Scores of Male and Female Students Taught Chemistry Using Computer Assisted Simulated Instruction (CASI).

Source	Type III Sum of Square	df	Mean Square	F	Sig
Intercept	132264.033	1	132264.033	4965.793	.000
GENDER	7.418	1	7.418	.278	.559
Error	2024.262	76	26.635		

Not Significant

The results showed that gender had no significant difference in the mean retention scores of students taught Chemistry using computer assisted simulation instruction Gender has p-value of .559. Since p-value is greater than the stipulated .05 level of significance showed that there is no significant difference. Thus, null hypotheses that stated that there is no significant difference in the mean retention scores of male and female students taught Chemistry using computer assisted simulation instruction is accepted. Hence, computer assisted simulation enhanced students' retention in Chemistry irrespective of gender.

Discussion of findings

The findings of this study were discussed under the following:

Students taught Chemistry using computer assisted simulation instruction had higher mean retention score than those taught using lecture method. There is statistically significant difference in the mean retention scores of students taught Chemistry using computer assisted simulation and that taught using lecture method.

The finding indicated that students taught Chemistry with computer assisted simulation approach showed statistically significant retention ability than those taught with lecture method. This means that teaching with computer assisted simulation approach enhanced and facilitated students' retention ability in Chemistry more than teaching with lecture method. This finding is in line with the findings of Birabil and Onwuke (2022), which stated that there was statistically significant difference in mean retention score of students when computer assisted simulation is used. In this study significant difference was observed in favour of computer assisted simulation instruction. This was so because computer assisted simulation is an interactive approach which involved the students in their learning process, thus helping the students to understand the concepts. Computer assisted simulation approach helps the participants recall or remember pieces of knowledge or skills that were learned earlier in time.

Male students taught Chemistry concept using computer assisted simulation instruction had more mean retention score than the female students, but there is no statistically significant difference in the mean retention scores of male and female students in the experimental group.

The finding showed that there was no statistically significant difference in the mean retention scores of male and female students taught Chemistry using computer assisted simulation approach. This means that teaching with computer assisted simulation approach enhanced students' retention in Chemistry irrespective of the gender.

The finding is in line with the findings of Birabil and Onwuke, (2022), Ikeanumba and Adigwe (2019) which stated that there is no significant difference in the mean retention scores of male and female students when computer assisted simulation is used. The finding is contrary to the findings of Egara and Mosimege (2023) which stated that there is statistically significant difference in mean retention scores of male and female students in favour of female. The non-significant difference among students' gender was because of the fact that any good strategy like computer assisted simulation approach help to enrich the learning experience of the students irrespective of gender.

CONCLUSION

This study demonstrates that computer-assisted simulation instruction (CASI) significantly improves students' retention in Chemistry. CASI makes concepts clearer and easier to understand, reduces the abstract nature of Chemistry topics, and promotes active student participation in the learning process. Through interactive and visual learning experiences, students are better able to grasp complex ideas and retain them over time.

The findings also indicate no significant difference in the retentive ability of male and female students, suggesting that CASI provides equal learning opportunities for all learners regardless of gender. This highlights its potential as an inclusive and effective instructional strategy in science education.

In summary, CASI should be integrated into the teaching of Chemistry and extended to other subjects, as it promotes meaningful learning, supports equity in education, and enhances both achievement and retention among secondary school students. Based on the findings of the study, the following recommendations were made;

1. Chemistry teachers are advised to use computer assisted simulation instruction because it is gender Inclusive.
2. There should be computer literacy/basic skills for secondary school teachers and students.
3. 3.CASI is suitable for teaching abstract concepts as it lends itself to repeated version.

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