# Effects of Mode of Computer Simulation on Students' Achievement and Interest in Chemistry in Enugu State, Nigeria

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## Abstract

*Using a sample of 204 students, the study investigated the effects of mode of computer simulation with on-screen text and narration (STN) and computer simulation with on-screen text only (ST) on students' achievement and interest in Chemistry in Enugu State. Guided by two research questions and two null hypotheses, the study adopted quasi-experimental research design. Four intact classes were used. During the lesson, simulation with on-screen text and narration was used in two schools (A&B), while in the other two schools (C&D), simulation with on-screen text only was used. Mean and the standard deviation were used to answer all the research questions, while analysis of covariance (ANCOVA) was used in testing all the hypotheses. Two instruments, Chemistry Achievement Test (CAT) and Chemistry Interest Inventory (CII), were used for the study. The CAT and CII were subjected to Kudder – Richardson 20 and Cronbach alpha statistics; a reliability coefficient of 0.96 and 0.84 were obtained respectively. Findings from this study showed, among others, that computer simulation with on-screen text and narration (STN) was more effective than simulation with on-screen text-only (ST). The study recommended that Chemistry teachers should use computer simulation with on-screen text and narration (STN) in teaching chemical bonding.*
**Keywords**: chemistry, computer, simulation, students, achievement

## Introduction

In Nigeria, the study of science is of great importance, that a lot of emphasis has been laid on the teaching and learning of sciences. The development of any nation is a measure of its growth in the area of science and technology. Thus in the world today, science and technology have become dominant power development indicator (Agbaje & Alake, 2014). In view of this, science is a search for evidence to answer questions or solve problems. It is also noted that science is a great enterprise which nations depend

on to advance technologically (Ghumdia, 2016). According to Ogunleye (2012), science is a dynamic human activity concerned with understanding the workings of the world. This understanding helps man to know more about the universe. Without the applications of science, it would have been difficult for man to explore the planets of the universe. This shows that science has a lot of importance especially for the country, Nigeria.

According to the National Policy on Education (Federal Republic of Nigeria [FRN], 2013), one of the specific goals of education in Nigeria is to promote information technology capability at all levels, and also to equip the students to live in this modern age. This can be achieved by inculcating in the learners the necessary scientific knowledge and attitudes through proper teaching of the various science subjects including Chemistry. Chemistry is the study of matter and energy and the interactions between them (Helmenstine, 2010; Bagley, 2014). In line with Hornby (2015), chemistry studied every substance scientifically, how they react and behave under different conditions and therefore has to be given its rightful place in a country's developmental scheme otherwise some countries will move from underdeveloped to super underdeveloped countries. As a core science subject, the proper teaching and learning of Chemistry in secondary schools facilitates students' enrollment in many professional disciplines like Nursing, Medicine, Pharmacy, Agriculture, Engineering and Geology, among others. Also, Ezeudu (2008) observed that Chemistry is an important science subject that has much influence on enhancing entrepreneurial skills. Therefore, the improvement of the life of the citizenry revolves around Chemistry education.

Chemistry Education can be seen as the acquisition of knowledge or ideals relevant to Chemistry. It is concerned with the impartment of knowledge on properties, components, transformations and interactions of matter. Chemistry Education is therefore the systematic process of acquiring the fundamental knowledge on the structure and nature of matter. It addresses the social objective of substance development as education is now the primary means for empowerment, participation, cultural preservation, social mobility and equity (Emmanuel, 2013). Chemistry education plays important role in enhancing the quality of teaching and research as well as ensuring that students are equipped with good knowledge to produce goods and services to meet human needs for food, healthcare products and other materials aimed at improving the quality of life.

Not minding the importance of chemistry, many students do not offer the subject in senior secondary school certificate examination (SSCE). They claim that chemistry content is difficult to retain due to its abstract nature and its involvement of too many calculations (Uchegbu et al., 2016). Previous researchers were in support of the view by investigating the causes and areas of learning difficulty in the teaching and learning

of chemistry in secondary schools (Agogo & Onda, 2014). Also Onochie (2018) pointed out some of the problems of science education in Nigeria as unstable staff, inadequate classrooms, inadequate equipment, poor knowledge and understanding, cost limitations and so on. These and other related factors are the root causes of poor teaching and learning delivery, leading to poor academic achievement to both teachers and students in schools.

Yusuf and Ali (2012) pointed out that students' poor achievement in science subject such as chemistry in the past was due to lack of interest in the subject, the content of the syllabus together with the ineffective teaching method used by the teachers as indicated by Olufumilayo (2018). Thus, an improper method of teaching by the teacher leads to improper understanding of the subject by the students. This seems to make the storage, retention, retrieval, general understanding and utilization of facts in chemistry difficult. In support of this, Duyilemi et al. (2014) maintained that the use of the conventional method in which the teacher dominates all the class activities right from the introduction to the conclusion of the lesson hinders students' initiatives, preventing them from fully exploring and understanding the subject being taught. According to the West African Examination Council (WAEC, 2010), the use of conventional teaching approach is deficient in meeting the needs of the majority of learners.

Therefore, there is need for the determination of the efficacy of new instructional methodologies in teaching and learning in this computer age where numerous information and communication technology (ICT) applications are available, aiming to stimulate students' active engagement in the teaching and learning process. Computer simulation is the imitation of the operation of the real-world process or system over time (Banks et al., 2010). Simulation includes role-plays, games and computer programmes that encourage students to become active participants in the classroom. Computer simulations are of special importance in Chemistry teaching and learning. For instance, Huppert et al. (2015), noted that in a computer simulation, students have opportunities to receive supplemental contact with the variables tested in real experiences. An interactive learning environment using simulations for the abstract topic, where students become active in their learning, provides opportunities for students to construct and understand difficult concepts more easily (Demirci, 2013). Also Mayer (2009) stated that cognitive theory of multimedia proposes that the use of text, audio and pictures will enable the learner to integrate them as learning experiences that will facilitate learning more than the use of only text or pictures. The study of Ezeudu and Okeke (2013) revealed that simulation increased students' achievement in Chemistry more than the conventional method.

Nowadays, computer simulation is an important tool for science education. A study by Ploetzner and Breyer (2017) shows that simulated images transform abstract idea into concrete images, thus improving the students' perception, understanding and attention. Therefore, it can be said that computer simulation may likely enhance students' achievement in various subjects. There are various modes of computer simulation, such

as computer simulation with on-screen text and narration (STN) and computer
simulation with on-screen text- only (ST). Computer simulation with on-screen text and
narration mode provides simulation and text on the computer screen and narration in
the background. In this mode, learners process the information through their eyes and
ears, focus on the simulation and text with their eyes and process the narration with
their ears. On the other hand, computer simulation with on-screen text-only provides
simulation and text on the computer screen and no narration in the background. In this
mode, learners focus on the simulation and text with their eyes and process the
information without activating the sense of hearing. Most secondary school students
learn most of their chemistry contents in nearly rote memorization and this makes
utilization of facts in chemistry difficult and leads to poor performance in the subject
(Diovu, 2004). It is left to be seen how modes of simulation will affect the students'
achievement and interest in Chemistry.

Achievement could be explained as an accomplishment of whatever goals one sets for
oneself. Goals in the context of this study are students' achievement. Also, Lamidi et
al. (2015) posit that academic achievement is something one does or achieves at school,
college or university, in class, in a laboratory and fieldwork. Academic achievement
helps in the proper evaluation of students and the identification of their strengths and
weaknesses. However, in the context of this study, academic achievement is the score
obtained by students in Chemistry after being exposed to simulation packages.

Related to students' achievement is their interest in chemistry. Interest can be defined
as a psychological state of having an affective reaction to and focused attention for
particular content and the relatively enduring predisposition to engage a particular class
of objects, events or ideas (Omebe, 2005). Interest is the formation of a relationship
between a person and an object (Onah, 2015). According to Onah, the students with
low interest in a subject are low achievers and those with high interest in a subject are
high achievers. The study by Odo and Odo (2016) found out that there is significant
effect of simulation method on students' interest in physics. Also, a study carried out
by Falode *et al.* (2016) found a significant difference in attitude of students in physics
due to treatment using computer simulation and the lecture method. Similarly, Attama
(2013) found that computer-assisted instruction had a significant effect on students'
interest in geography.

Interest is very important in one's educational and life success. In view of this, Hidi and
Renninger (2016) opined that a person's level of achievement increases intrinsic
motivation, a construct that is related to an individual's interest. Studies have shown
that secondary school students exhibit low interest in Chemistry (Esiobu, 2005). The
low interest of students in Chemistry has been traced to poor achievement in
examinations (Gilakjani, 2012). There is also a correlation between student's interest
and teaching methods used by teachers. Students may have different interest in
chemistry due to the use of simulation with on-screen text and narration, and simulation

with on-screen text- only. In the context of this study, interest is the response of the students to the attractiveness of chemistry by their inclination to study and do exercises in it.  From the forgoing, there is the need to examine the effects of computer simulation modes on students' achievement and interest in Chemistry which is the problem of this study.

**Purpose of the study**
The purpose of this study is to determine the effects of mode of computer simulation on students' achievement and interest in Chemistry in Enugu State, Nigeria. Specifically, the study determined the:
    1.   effect of computer simulation with on-screen text and narration and with on-screen text-only on students' achievement in Chemistry.
    2.   effect of computer simulation with on-screen text and narration, and with on-screen text-only on students' interest in Chemistry.

**Research questions**
The following research questions were posed to guide the study:
    1.   What are the relative mean achievement scores of students taught Chemistry using computer simulation with on-screen text and narration, and those taught using computer simulation with on-screen text-only?
    2.   What are the relative mean interest scores of students taught Chemistry using computer simulation with on-screen text and narration, and those taught using computer simulation with on-screen text-only?

**Hypotheses**
The following null hypotheses were formulated to guide the study and tested at 0.05 level of significance:
    **Ho1:** There is no significant difference in the mean achievement scores of students taught Chemistry using computer simulation with on-screen text and narration, and those taught using computer simulation with on-screen text-only.
    **Ho2:** There is no significant difference in the mean interest scores of students taught Chemistry using computer simulation with on-screen text and narration, and those taught using computer simulation with on-screen text- only.

**Methodology**
The study adopted a quasi-experimental factorial research design. Specifically, a 2x2x2 factorial non-equivalent control group design was adopted for the study. The population of this study comprised 5,272 SSI Chemistry students in public secondary schools in Enugu Education zone of Enugu State Nigeria. The sample for this study was 204 Senior Secondary one (SSI) Chemistry students comprising 96 males and 108 females drawn from four public senior secondary schools in Enugu Education Zone of Enugu State. Purposive sampling technique was used to select four schools that have common characteristics such as well-equipped computer laboratory; experienced chemistry

teachers, and electricity. Two schools, A and B, were randomly assigned to computer simulation with on-screen text and narration, and the other two schools C and D were assigned to computer simulation with on-screen text-only.

Chemistry Achievement Test (CAT) and Chemistry Interest Inventory (CII) were adapted and used for pretest and posttest. Chemistry Achievement Test (CAT) consists of 50 achievement test questions, with response options A to D. The scoring was two marks each. Three experts, two in Science Education and one in Measurement and Evaluation, all from the Faculty of Education, University of Nigeria, Nsukka, validated the instruments. CAT and CII were administered to twenty four SS I Chemistry students of a secondary school in Enugu State, which were not part of the study. The scores obtained by the students in CAT were subjected to Kuder-Richardson (KR-20) formula, while that of Chemistry Interest Inventory (CII) were subjected to Cronbach Alpha statistic, and an internal consistency reliability coefficient of 0.96 and 0.84 respectively were obtained for the instruments.

In this study two modes of computer simulation instructional package were used. They are computer simulation with on-screen text and narration (STN), and computer simulation with on-screen text only (ST). The two groups of subjects were: experimental group 1 (STN) and experimental group 2 (ST). The two instructional approaches acted as a control for each other. Students in experimental group 1 were taught using computer simulation with on-screen text and narration (STN), while the students in experimental group 2 were taught using computer simulation with on-screen text-only (ST). Teaching lasted for six weeks, at the end of which the CAT and CII were administered to all the groups again. The scores obtained at this stage serve as posttest scores. The scores obtained from students in the different groups in both the pretest and posttests were subjected to data analysis. Mean and standard deviation were used in answering all the research questions, while Analysis of Covariance (ANCOVA) was used to test the formulated hypotheses at 0.05 level of significance.

**Presentation of results**

**Research question 1:** What are the relative mean achievement scores of students taught using simulation with on-screen-text and narration, and simulation with on-screen-text-only in Chemistry?

**Table 1:** Mean ($\bar{x}$) and standard deviation (SD) scores by mode of simulation

| Mode | N | Pretest | | Posttest | | $\bar{x}_{adj}$ |
|------|---|---------|---|----------|---|-----------------|
| | | $\bar{x}_1$ | $SD_1$ | $\bar{x}_2$ | $SD_2$ | |
| Simulation with on-screen-text and narration | 102 | 13.88 | 3.64 | 29.09 | 2.67 | 28.83 |
| Simulation with on-screen-text-only | 102 | 12.49 | 3.04 | 22.71 | 2.97 | 23.14 |
| Total | 204 | 13.19 | 3.42 | 25.90 | 4.27 | |

Results in table 1 show that the adjusted mean for simulation with on-screen-text and narration ($\bar{x}_{adj} = 28.83$) is higher than that of simulation with on-screen-text-only ($\bar{x}_{adj} = 23.14$). Therefore, simulation with on-screen-text and narration was more effective than the simulation with on-screen-text-only on students' achievement in Chemistry.

**Ho1**: There is no significant difference in the mean achievement scores of students exposed to simulation with on-screen-text and narration, and simulation with on-screen-text-only in Chemistry in Enugu State.

**Table 2:** ANCOVA test scores by Mode of Simulation and students achievement in Chemistry

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 2668.421[a] | 8 | 333.5553 | 63.492 | .000 | .723 |
| Intercept | 4225.338 | 1 | 4225.338 | 804.302 | .000 | .805 |
| Precat | 557.225 | 1 | 557.225 | 106.069 | .000 | .352 |
| Mode | 1269.518 | 1 | 1269.518 | 241.655 | .000 | .553 |
| TOLT | .889 | 1 | .869 | .165 | .685 | .001 |
| Gender | 10.868 | 1 | 10.868 | 2.069 | .152 | .010 |
| Mode X TOLT | | | | | | |
| Mode X Gender | 5.728 | 1 | 5.728 | 1.090 | .298 | .006 |
| TOLT X Gender | .009 | 1 | .009 | .002 | .967 | .000 |
| Mode X TOLT X Gender | .059 | 1 | .059 | .011 | .915 | .000 |
| | 1.023 | 1 | 1.023 | .195 | .659 | .001 |
| | 1024.418 | 195 | 5.253 | | | |
| Error | 140507.000 | 204 | | | | |
| TotaI Corrected | 3692.838 | 203 | | | | |
| Total | | | | | | |

$R^2 = .723$; Adjusted $R^2 = .711$

Results presented in table 2 show that for the mode of simulation, $F_{(1,195)} = 241.655$, $p<0.000$. Therefore, the mode was a significant factor in the achievement of the students at $p< .05$. The null hypothesis of no significant effect of mode of simulation is thereby rejected. There is a significant difference in the mean achievement scores of the student, in favour of students exposed to simulation with on-screen-text and narration as shown in table 1. Mode of simulation explained (effect size $= 0.553$ x 100) for 55.3% of the variance in the achievement scores of the students.

**Research Question 2:** What are the relative mean interest scores of students taught Chemistry using simulation with on-screen-text and narration and simulation with on-screen-text- only?

**Table 3:** Mean ($\bar{x}$) and standard deviation (SD) interest scores by mode of simulation

| Mode | N | Pretest | | Posttest | | $\bar{x}_{adj}$ |
|---|---|---|---|---|---|---|
| | | $\bar{x}_1$ | $SD_1$ | $\bar{x}_2$ | $SD_2$ | |
| Simulation with on-screen-text and narration | 97 | 84.96 | 11.96 | 80.88 | 10.05 | 81.29 |
| Simulation with on-screen-text-only | 84 | 85.86 | 9.85 | 81.94 | 10.67 | 81.92 |
| Total | 181 | 85.41 | 10.93 | 81.37 | 10.33 | |

Results in table 3 show that the adjusted mean for simulation with on-screen-text and narration ($\bar{x}_{adj}= 81.29$) is lower than that of simulation with on-screen text-only ($\bar{x}_{adj}= 81.92$). Therefore, simulation with on-screen-text-only was slightly more effective than simulation with on-screen text and narration on students' interest in Chemistry in Enugu State.

**Ho2:** There is no significant difference in the mean interest scores of students' exposed to simulation with on-screen-text and narration, and simulation with on-screen-text-only in Chemistry.

**Table 4:** ANCOVA test scores of mode of simulation and students' interest in Chemistry

| Source | Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 952.660[a] | 8 | 119.075 | 1.150 | .333 | .052 |
| Intercept | 15545.957 | 1 | 15545.957 | 150.161 | .000 | .472 |
| Preint | 181.794 | 1 | 181.794 | 1.756 | .187 | .010 |
| Mode | 12.614 | 1 | 12.614 | .122 | .727 | .001 |
| TOLT | 33.212 | 1 | 22.212 | .321 | .572 | .002 |
| Gender | 16.280 | 1 | 16.280 | .157 | .692 | .001 |
| Mode X TOLT | .893 | 1 | .893 | .009 | .926 | .000 |

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|---|---|---|---|---|---|---|
| Mode X Gender | 244.521 | 1 | 224.521 | 2.362 | .126 | .014 |
| TOLT X Gender | 134.996 | 1 | 134.996 | 1.304 | .255 | .008 |
| Mode X TOLT X Gender | 20.714 | 1 | 20.714 | .200 | .655 | .001 |
| Error | 17392.790 | 168 | 103.529 | | | |
| Total | 1197694.000 | 177 | | | | |
| Corrected Total | 18345.390 | 176 | | | | |

$R^2 = .052$; Adjusted $R^2 = .007$

Results presented in table 4 show that for mode of simulation $F_{(1,168)} = 0.122$, $p = 0.727$. The F- ratio is not significant at $p > .05$. Therefore, there is no significant difference in the mean interest scores of students taught simulation with on-screen-text and narration, and simulation with on-screen-text-only. Mode of simulation explained only (effect size .001x100) = 0.1% variance in the interest scores of the students.

**Discussion of the findings**
Findings of the study reveal that there was a significant difference in the mean achievement scores of the students, in favour of students exposed to simulation with on-screen-text and narration (STN). Simulation with on-screen-text and narration was more effective than simulation with on-screen-text-only (ST). The students used in the study are concrete operators who can only learn effectively with concrete materials. The use of STN provided a more concrete learning experience than those taught using ST. This may explain why STN was more effective than ST in facilitating students' achievement in Chemistry. Also, STN provided opportunity for the learners to use the senses of sight and hearing in the instructional process, while ST made it possible for students to use only the senses of sight thereby providing less learning experience compared to STN. This findings is in agreement with the Mayer (2009) cognitive theory of multimedia which proposes that the use of text, audio and pictures will enable the learner to integrate them as learning experiences that will facilitate learning more than the use of only text or pictures. The finding also validates the earlier reviewed study conducted by Ezeudu and Okeke (2013) which found that simulation increased students' achievement in Chemistry more than the conventional method. The findings of both studies indicate the consistency in the effectiveness of computer simulation on achievement in Chemistry.

The finding of the study also indicated that there is no significant difference in the mean interest scores of students taught using simulation with on-screen-text and narration (STN), and simulation with on-screen-text-only (ST) in Chemistry. This finding

indicates that the learners were equally excited by the two modes. This finding is not in agreement with the study of Hidi and Renninger (2016) which found that there was significant difference in students' interest in chemical bonding due to the use of animation strategy. The findings did not agree with that of Attama (2013) who found that computer-assisted instruction had a significant effect on students interest in geography; it did not agree also with that of Odo and Odo (2016) who found significant effect of simulation method on students interest and that of Falode *et al.* (2016) which found a significant difference in attitude of students in physics due to treatment using computer simulation and the lecture method.

## Conclusion

The group that was taught using simulation with on-screen-text and narration (STN) performed better than the group taught using simulation with on-screen-text-only (ST). But the group exposed to simulation with on-screen-text and narration did not show more interest than the group exposed to simulation with on-screen-text-only.

## Recommendations

The following recommendations were made:

1. Secondary school teachers of chemistry should use simulation with on-screen-text and narration for students, irrespective of logical thinking ability and gender, since it makes learning more effective than the simulation with on-screen-text-only.

2. Workshops and seminars should be organized for serving teachers by the Nigerian Association of Educational Media and Technology (NAEMT), Science Teachers Association of Nigeria (STAN), and Post Primary School Management Board (PPSMB), to equip teachers with the necessary skills for the development and use of computer simulation in Chemistry instruction.

3. Educational Resource Centres, especially computer laboratory resources, should be created in schools, and funds made available to teachers to enable them to engage in research and production of computer simulation instructional materials.

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