PRINT: ISSN 0975-1122 ONLINE: 2456-6322
Int J Edu Sci, 12(2): 155-168 (2016)
DOI: 10.31901/24566322.2016/12.02.07

Promoting Intrinsic and Extrinsic Motivation among Chemistry Students Using Computer-assisted Instruction

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KEYWORDS Chemistry. Computer. Extrinsic Motivation. Gender. Intrinsic Motivation. Simulation

ABSTRACT This study established the effects of computer-assisted instruction in promoting intrinsic and extrinsic motivation among 90 senior secondary one (SS1) students from three secondary schools in Minna, Niger state Nigeria. A pre-test and post-test experimental design was used during which students were randomly assigned into either the experimental groups or the control group. The experimental group I was taught two selected concepts of chemistry using a computer simulation instructional package (CSIP), the experimental group II was exposed to computer tutorial instructional package (CTIP) while a conventional teaching method (CTM) was used for the control group. The Chemistry Achievement Test (CAT) and Chemistry Motivation Questionnaire (CMQ) were used for data collection. Additional qualitative data was collected using classroom observations as well as interview schedules. The outcome of this study revealed that students taught with CSIP performed better than those in CTIP and CTM groups. The CSIP and CTIP were found also to be gender friendly. Based on the findings, it was recommended that chemistry teachers should employ computer simulation for improving their students' performance and motivation in the subject.

INTRODUCTION

The secret of technological development of any nation lies in the study of science. Unfortunately, the study of science in Nigeria has been impeded by a lot of bottlenecks right from primary school through secondary to tertiary level of education (James 2001). The importance of chemistry in science and technology cannot be overemphasized. Chemistry is often called 'the central science', because its interests lie between those of physics and biology. The Nigerian government, having realized the importance of chemistry in the field of science and technology, made it one of the core courses to be offered to science-oriented students (FRN 2008). In the last decade, reports have shown that secondary school students' performance in chemistry at national examinations in Nigeria has been very poor as revealed in Table 1. From research evidences, educators see the pressing need to reconsider the techniques and methods of instruction. To address these challenges and issues, there is the need for an instructional system and support technology to give consideration to meaningful learning in basic science.

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Table 1: Percentage performance of students in May/June WASSCE, 2005-2011 in Nigeria at credit level and above

Year	*Biology*	*Chemistry*	*Mathematics*	*Physics*
2005	35.74	50.94	38.20	41.53
2006	49.23	44.90	41.12	58.02
2007	33.37	45.96	46.75	43.19
2008	33.94	44.44	57.27	48.26
2009	28.58	43.69	47.04	47.83
2010	50.70	49.65	41.16	20.98
2011	37.80	48.68	31.88	62.84

Source: WAEC, Lagos, Nigeria

According to Olorukooba (2007) and Jegede (2007), students consider chemistry to be a difficult field of study. The students' inability to comprehend and remember what has been learnt is mostly caused by a teacher-centered approach that makes learners passive listeners. The persistent use of traditional teaching methods where chemistry teachers transmit knowledge to the students who most of the times are inactive in the classroom have not been promoting effective learning. Lack of motivation has been identified as one of the causes of poor performance in science. Glynn et al. (2007, 2009) concluded that students' motivation towards learning science is positively related to their performances in science.

Balancing of equations and periodicity constitute parts of chemistry concepts that teachers find difficult to teach their students, and students also find it difficult to understand (WAEC 2012). Science courses require students to recall many facts and then connect old and new concepts. Students often rely on surface strategies for memorizing facts without any focus on content comprehension or connections between known and unknown concepts (Momsen et al. 2013). This poses a problem for college science teaching, because if meaningful learning does not occur, students may not truly understand the material and ultimately make necessary connections for solving problems (Cavallo et al. 2004). The absence of meaningful learning may be due to the manner in which material is presented or to the lack of awareness of actual skills needed to reach meaningful learning levels (Gambari 2010).

Traditional instructional methods have given insufficient opportunities to students to construct their own learning. Eliciting students' individual capabilities, intelligence and creative thinking can only be achieved through student centered instructional methods (Adegoke 2011). Large enrollment in science courses, make it difficult to address the specific needs of individuals. Anecdotal evidence suggests that many of these students are poorly motivated, do not see the relevance of science to their careers, and find science frustratingly difficult (Emeke and Adegoke 2001; Arwood 2004; Cavallo et al. 2004). Poor motivation in science often leads to low achievement (Glynn et al. 2007). In order for students to be motivated to learn in any discipline, they must participate in activities that are personally meaningful and worthwhile (Glynn and Koballa 2006).

Computer-assisted Instruction (CAI) software could be used to transform classroom instruction into a series of rich memorable experiences and therefore, reduce boredom and forgetfulness (Achuonye 2011; Yusuf and Afolabi 2010). It can also solve the problem of lack of instructional material for teaching chemistry, and it can be used to change the students' perspective that chemical concepts are abstract and difficult to understand. Computer supported learning environments offer several facilities that can be used to improve the teaching and learning of chemical processes. Computer enables repeated trials of an experiment with considerable ease in a limited time. It provides immediate feedback, allows simultaneous observation of graphical representations, and offers a flexible environment that enables students to proceed on their own pace (Gambari 2004; Kara and Yesilyurt 2007). Major classifications of CAI lessons include tutorials, drill and practice, simulations, and instructional games (Badmus 2007). Each basic design provides a unique method for using the computer to teach, reinforce, practice or apply information.

Using an interactive learning environment such as computer simulations and tutorial instruction to teach abstract topics enables students to become more active learners. It also provides opportunities for students to construct and understand difficult concepts more easily (Gambari et al 2014; Nadelson et al. 2015). According to Burns and Myhill (2004), complex information given to students can be simplified through the use of technology, which offers them opportunities to learn by doing. Computer simulation is an example of technology that could be adopted for teaching and learning purposes. Using it for teaching can help reduce the costs associated with the chemicals and equipment necessary for laboratory experiments. They can also save time in situations where there are few variables being examined. It is considered that if used adequately, simulations would make it easy to control variables and may even prevent traditional classroom management problems (Gambari et al. 2012). Integrating computer simulations into teaching and learning help students integrate separate facts, concepts, and principles into functional units and assimilate them with other units. They are used in situations where several knowledge elements have been learned independently and must be applied collectively (Efe and Efe 2011).

Previous studies have demonstrated the effectiveness of computer simulations on student learning. Studies suggest that well-designed computer simulations have positive effects on learning, creativity, decision-making, communication, thinking power and initiatives (Akpan and Andre 2000; Winberg and Headman 2007;

Saminathan 2012). A good number of these studies have focused on the acquisition of specific content knowledge. For example, Akpan and Andre (2000) found that students who used a computer simulated frog dissection learned significantly more on anatomy courses than those who performed actual dissections. Winberg and Headman (2007) developed a computer-simulated pre-lab, which aimed to prepare students cognitively to real laboratory activity about acid-base titration. As a result of their study, they concluded that the experimental group showed a positive attitude towards learning. Saminathan (2012) found Computer-Based Instructional Strategies to be an effective teaching strategy than the traditional method of teaching chemistry. Recent study by Nadelson et al. (2015) revealed that using video-based demonstrations to prepare students for the organic chemistry laboratory resulted in greater learning gains for the treatment group as compared to the control group who were taught using the traditional method. It was also reported that students in the treatment group who watched the videos as part of their pre-laboratory instruction completed their experiments within a short time.

Other investigations have reported less impressive results in utilizing computer simulations in science instruction. Some of these have found no advantage to using simulations over traditional methods. For example, Winn et al. (2006) compared college undergraduate's achievement of oceanography concepts through field and simulated experiences. Results indicated that there was no difference in overall learning between the fieldwork and simulation groups.

In a computer tutorial, information is taught, verified, and reinforced through interaction with the computer. Tutorials are often categorized as linear and branching tutorials (Egunjobi 2004). A simple, linear tutorial gives the same instructional sequence of explanation, practice, and feedback to all learners regardless of differences in their performance. A more sophisticated, branching tutorial directs learners along alternate paths depending on how they respond to questions and whether or not they show mastery of certain parts of the material. Even branching tutorials can range in complexity by the amount of branching they allow and how fully they diagnose the kinds of instruction that a student needs (Doering and Veletsianos 2009). Students are typically questioned during the tutorial to verify comprehension. Tutorials should teach well-defined objectives thoroughly enough to eliminate the need for repetition through another teaching system (Kara and Yesilyurt 2007).

Literature evident in Egunjobi (2004), Badmus (2007) and Carmelita (2008) have revealed the effectiveness of the computer tutorial mode over the traditional method in classroom settings across different disciplines at secondary schools level both in Nigeria and outside Nigeria. For instance, Kara and Yesilyurt (2007) assessed the effects of tutorial and edutainment software programs on students' achievements, misconceptions and attitude towards biology. After the treatment, tutorial and edutainment improved the students' performance and changed their attitudes towards biology. Similarly, as Egunjobi (2004) reported, students taught some concepts in geography using a computer tutorial mode performed better than those in computer game and computer drill and practice instructional groups, respectively. Akram et al. (2011) reported the effectiveness of computer tutorial on the chemistry students' achievement over traditional method at higher level. However, other studies such as Ramanchandram and Scottler (2003) found no significant difference between the traditional method and tutorial mode on achievement. Most of these studies were based on the regularly used tutorial mode, which incorporated text-only strategy and did not utilize pictures and audio.

Gender has been identified as one of the factors influencing the students' performance at Senior Secondary School level in Nigeria (Anagbogu and Ezeliora 2007). Different results and views of researchers as in studies of different subjects such as science, arts and vocational education in developing countries show that female and male students perform differently as a result of cultural and traditional reasons (Wasagu and Muhammad 2007). Although some researchers (Adesoji and Babatunde 2005; Gambari 2004; Fagbemi et al. 2011) found that male and female students performed equally well in chemistry, biology, physics and social studies) using computer-based instructional packages. Therefore, it is not clear how gender will influence learning when the different strategies of the simulation and tutorial modes are used in teaching chemistry. Hence, the inclusion of gender in this study became very necessary.

Motivation is one of the states that drives and sustains learning behaviors. There are many motivational constructs that could relate to academic success in college science. However, researchers have identified intrinsic and extrinsic motivation, goal orientation, task value, self-determination, self-efficacy and assessment anxiety as important constructs for science learning (Glynn and Koballa 2006; Glynn et al. 2009). However, this present study focused on intrinsic and extrinsic motivation as predicator of success in chemistry.

Intrinsic motivation refers to internal desires to perform a particular task, which is rewarded by completing the task itself, whereas extrinsic motivation refers to performance of a task in order to receive an external reward (Ryan and Deci 2000). In academic situations, intrinsic motivation leads to deeper processing, greater mastery and better implementation of learning strategies (Covington 2000). Intrinsically motivated students are also more likely to persist with challenging tasks and other positive classroom behaviors as well as perform better academically than extrinsically motivated students who might have to been bribed before they perform the given tasks (Ryan and Deci 2000; Walker et al. 2006).

Extrinsic motivation generally drives behaviors when students complete tasks for an external outcome. Extrinsically motivated students who fall closer to active personal commitment on the continuum may be driven to act primarily because of the reward. However, these rewards may also have some intrinsic elements, for instance, receiving an 'A' grade makes the student feel good (Walker et al. 2006).

Motivation to learn science at the Junior Secondary School level (Middle School) is one of the most important predictors of science course success (Britner and Pajares 2006). Moos (2010) reported that participants who had high extrinsic and high intrinsic motivation used significantly more planning and monitoring processes when compared to participants who had lower motivation scores for either the extrinsic or intrinsic category. Additionally, participants who had high extrinsic and high intrinsic motivation significantly outperformed those who had low extrinsic and low intrinsic motivation.

Considering the general academic success, Kaufman et al. (2008) investigated whether intrinsic and extrinsic motivation separately predicted students' performance. A significant positive relationship between intrinsic motivation and students' performance was found, and there was a negative relationship between extrinsic motivation and students' performance (Kaufman et al. 2008). Watson et al. (2004) studied the effects of both intrinsic and extrinsic motivation on a specific college final course grade. They found that higher levels of both motivation orientation variables positively correlated with higher course grades (Watson et al. 2004). Garcia (1993) found both intrinsic and extrinsic motivation positively predicted final course grades in organic chemistry. In contrast, Yu (1999) found that intrinsic motivation negatively predicted course performance in college chemistry. Glynn et al. (2007) investigated the relationship between overall motivation to learn science and science performance. They reported that students found science courses relevant to their careers, and both their motivation and science performance were higher. In another study, Glynn (2009) found that when college students reported lower motivation in science courses their performance was lower as well. However, students can be simultaneously intrinsically and extrinsically motivated (Kaufmann et al. 2008; Watson et al. 2004; Lin et al. 2002).

In spite of the unprecedented impact of Computer-assisted Instruction (CAI) on science education in advanced countries, it has not made much headway in Nigeria. Little is known about the use of computer-assisted instructional package in the Nigerian educational system particularly the use of simulation and tutorial modes. In addition, very few empirical studies exist in Nigeria regarding the use of CAI as a motivator to chemistry learning. Therefore, much remains to be empirically studied on the effect of CAI in chemistry education, in Nigeria. Based on this fact, this present study examined the effects of two modes of computer-assisted instruction (tutorial and simulation) on the academic performance and motivation of chemistry students in senior secondary one in Minna, Niger State, Nigeria.

Research Questions

This present study is guided by the following research questions:

1. What are the differences in the achievement of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method?

2. Is there any difference in the mean achievement scores of male and female students exposed to computer simulation instructional package?
3. Is there any difference in the mean achievement scores of male and female students exposed to computer tutorial instructional package?
4. What are the differences in the intrinsic motivation of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method?
5. What are the differences in the extrinsic motivation of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method?

Research Hypotheses

The following null hypotheses were formulated and tested at a 0.05 level of significance:

1. There are no significant differences in the performance of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method.
2. There is no significant difference in the mean achievement scores of male and female students exposed to computer simulation instructional package.
3. There is no significant difference in the mean achievement scores of male and female students exposed to computer tutorial instructional package.
4. There are no significant differences in the intrinsic motivation of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method.
5. There are no significant differences in the extrinsic motivation of students taught chemistry using computer simulation instructional package, computer tutorial instructional package and conventional teaching method.

METHODOLOGY

Study Design

This study adopted the pretest-posttest experimental group design, one of the quantitative research methods. Three levels of independent variables (two experimental groups and a control) and two levels of gender (male and female) were used. The experimental group I was taught two selected concepts of chemistry using the computer simulation instructional package (CSIP), experimental group II was taught the same concept using the computer tutorial instructional package (CTIP) whereas the control group received the conventional teaching method (CTM). Comparisons of the academic performances and motivation of the learners in chemistry were drawn by comparing the responses of the learners in the three groups.

Population and Sample

Multi-stage sampling techniques were adopted for the purpose of this study. Firstly, a purposeful sampling procedure was adopted to obtain three secondary schools in Minna metropolis of Niger State, Nigeria. These schools were sampled based on facilities (laboratories and manpower), school type (public schools), and gender composition (co-educational schools). The three schools were randomly assigned to experimental group I (CSIP group), experimental group II (CTIP group) and control group (CTM group), respectively. A stratified sampling technique was used to select the 90 SSI students. Each group had 30 students (15 male and 15 female). Finally, purposeful sampling was also used to select 5 students from each of the groups for the interview scheduled.

Research Instruments

Data was collected using the Chemistry Achievement Test (CAT), Chemistry Motivational Questionnaire (CMQ) and an interview guide as well as classroom observations. Both CAT and CMQ were administered by the first researcher as a pre-test and subsequently as a post-test. Questions in the post-test were the same like those used in the pre-tests. However, questions in the post-tests were numbered differently to avoid recognition. The pre-tests assessed the two experimental groups and the control groups' prior knowledge of the chosen chemical concepts while the CMQ assessed their motivation toward chemistry learning. The post-tests assessed the learners' understanding and motivation of concepts after the instruction. An interview guide of open-ended questions was also used to collect detailed information from five selected learners in each group regarding the subject to determine their motivation towards chemistry. The classroom observations were also carried out in order to determine what the students were actually doing during the lessons.

Chemistry Achievement Test (CAT)

The Chemistry Achievement Test (CAT) consists of 50 multiple choice objective items with five options (A to E) adopted from past examinations of the West African Examination Council (WAEC, May/June 2008-2012) and National Examination Council (NECO, June/July, 2008-2012). The content validity of CAT was established by matching the test items with the subject matter outlined in the Nigerian chemistry O-level teaching syllabus. The appropriateness of the options provided for each item was checked by four independent reviewers (subject teachers, test and measurement experts, university lecturers and secondary school teachers) and suggestions were incorporated in the final version, which consisted of 50 questions. To establish the reliability of CAT, the achievement test was piloted to 50 learners in another school within the same local government and a Cronbach Alpha coefficient of 0.89 was obtained and this was considered acceptable.

Chemistry Motivational Questionnaire (CMQ)

The Chemistry Motivational Questionnaire (CMQ) was adopted from the Science Motivation Questionnaire by Glynn and Koballa (2006). The Science Motivational Questionnaire (SMQ) has six motivational components, each component has a five-item five point scale and the associated items included intrinsically motivated science learning, extrinsically motivated science learning, personal relevance of learning science, self-determination (responsibility) for learning science, self-efficacy (confidence) in learning science, and anxiety about science assessment. In this study, two components were chosen for measuring the intrinsic and extrinsic motivation of students toward chemistry. CMQ has ten-items which contain 5-items for intrinsically motivated chemistry learning (items 1, 2, 3, 4, and 5), and 5-items for extrinsically motivated chemistry learning (items 6, 7, 8, 9, and 10). It consists of five-point Likert type items (Never, coded as 1; Rarely, coded as 2; Sometimes, coded as 3; Usually, coded as 4, and Always, coded as 5).

Examples of items in intrinsically motivated chemistry learning component include, “I enjoy learning the chemistry”, and “The chemistry I learn is more important to me than the grade I receive”. Examples of items in extrinsically motivated chemistry learning components include, “I like to do better than the other students on the chemistry test” and “I think about how my chemistry grade will affect my overall grade point average”. Glynn et al. (2007) had earlier pilot studied the 30-item Science Motivation Questionnaire with science and non-science majors students and 0.93 reliability coefficient was obtained using Cronbach Alpha reliability coefficient. These items were found to be reliable and valid. SMQ items, which had been previously used for college students, are therefore considered to be suitable for Senior Secondary One science students in Nigeria.

Interview Schedule

In order to get a deeper understanding of the students’ intrinsic and extrinsic motivation, five students were interviewed from each group. The students were asked questions such as, “Based on the two topics you have learnt so far,

1. Did you enjoy learning the chemistry?
2. Do you think you have accomplished a lot by learning chemistry this way?
3. Do you think that using computer simulations could help you to understand chemistry better?
4. Do you think you will do better than the other students on the tests?”

Learning Environment

The learning environment for this study comprised of Computer Simulation Package (CSP) and Computer Tutorial Package (CTP). The packages, which were validated by team of experts, consist of concepts of periodicity and chemical equations.

In the Computer Simulation Package, the computer presents information and displays animations to the learner in each of the units. Information is presented in the form of a frame, mastery of a frame led to the presentation of the next frame. In other words, students could only proceed to the next frame if they satisfactorily answered the questions in that frame. This approach uses drill and practice and it allows students to move at his/her own pace, get immediate feedback, and feel the movement of the objects among others.

In the Computer Tutorial Package, computer displays information to the learner on each of the units with static pictures after which the students jot down the key concepts in their notebook. At end of each unit, students assessed themselves with objective questions. The computer displays the number of questions scored correctly and those wrongly answered. The correct answers were displayed against the wrong answers for students to compare and make corrections. Students moved to the next lesson if they satisfactorily answered the questions and obtained a score of seventy percent. However, when a student fails more than three questions (30%), the computer package will give a remedial lesson on that particular concept or questions before he/she moves to the next unit.

Research Procedure

After obtaining permission from the three schools' administrators to conduct the study, the researcher installed both CSP packages on the desktop computer system of treatment groups. The objectives and the modalities of the experiments were specified and operational guide was produced before the commencement of the treatment. After this, the researcher administered both CAT and CMQ pre-tests to the sampled students. This helped ascertain the equivalence of the students before the treatment. Treatment was followed immediately. The two experimental groups were taught periodicity and chemical equations using Computer Simulation Package (CSP) and Computer Tutorial Package (CTP) respectively over a period of four weeks. By incorporating computer simulation packages into the teaching of periodicity and chemical equations, the researchers assume that simulations would impact the learners' learning by developing the learners' ability to break down the complex and abstract structure of the periodic table and balancing of the chemical equations. It will also enable the learners to resolve any misconceptions they might have about the concepts and improve their conceptual understanding. On the hand, the control group was taught using the traditional method where the teachers will just teach the learners and give them notes to read on their own but no computer simulations were used for them. Thereafter, CAT and CMQ were administered as post-tests to measure the achievement and motivation of the sampled students in each of the school.

Data Analysis

Both quantitative and qualitative data was collected for the purpose of this research. The quantitative data collected was analyzed using the Statistical Package for Social Scientists (SPSS) version 18. The data was analyzed based on the stated hypotheses using both descriptive statistics (mean and standard deviation) and inferential statistics (t-test, one-way Analysis of Variance (ANOVA) and Scheffe's test). The significance of the various statistical analyses was ascertained at 0.05 alpha levels.

Data obtained from the guided interviews and classroom observations was analyzed thematically using the Braun and Clarke (2006) approach where texts were read and reread to decontextualize bits of information from primary data. Information was grouped into similar, dissimilar components and later reexamined against the purpose of study in order to generate themes.

RESULTS

The overall scores of the pre-test for the computer simulation instructional package (CSIP) were mean is 82.87± 2.3 SD, scores for the computer tutorial instructional package (CTIP) were mean is 76.13±1.8 SD, while that of the conventional teaching method (CTM) were mean is 63.37 ±1.8 SD.

Hypothesis One: There are no significant differences in the performance of students taught chemistry using computer simulation instructional package (CSIP), computer tutorial instructional package (CTIP) and conventional teaching method (CTM).

To determine whether there were significant differences in the post-test mean scores of the CSIP, CTIP and CTM, data was analyzed using the analysis of variance (ANOVA) as shown in Table 2.

Table 2 shows the pre-test results of ANOVA comparing two experimental groups and control group. From Table 2, the F-value (1.07, $p = 0.35$) was not significant at 0.05 alpha level. This

Table 2: ANOVA pre-test on CSIP, CTIP and CTM groups

Test	Source of variables	Sums of square	df	Mean square	F-value	p-value
	Between groups	13.27	2	6.63		
Pre-test	Within groups	541.23	87	6.22	1.07^{ns}	0.35
	Total	554.50	89			
	Between groups	5885.76	2	2942.88		
Post-test	Within groups	1193.90	87	13.72	214.45^{*}	0.00
	Total	7079.66	89			

ns: Not Significant at 0.05 level * Significant at 0.05 level

implies that there was no significant difference among the mean scores of the experimental group I, experimental group II, and the control group at a 0.05 level of significance.

From Table 2, post-test result of ANOVA comparing two experimental groups and control group shows the F-value (214.45, p = 0.00) was significant at 0.05 alpha level. This indicates that a statistically significant difference was established among the experimental groups and control group. Hence, the null hypothesis one (H_{O1}) was rejected. Based on the established significant difference in the post-test scores of the groups, Scheffe's test was used for post-hoc analysis. The results of this post-hoc analysis are as shown in Table 3.

Table 3: Scheffe's post-hoc analyses of the groups mean scores

Groups	Mean scores	CSIP	CTIP	CTM
CSIP	82.87		0.00*	0.00*
CTIP	76.13	0.00*		0.00*
CTM	63.37	0.00*	0.00*	

* The mean difference is significant at the 0.05 level

The result in Table 3 indicates that there was significant difference in the post-test mean scores of students exposed to CSIP (X = 82.87) and those exposed to CTIP (X = 76.13). It indicates a significant difference in the post-test mean scores of students exposed to CTIP (X = 76.13) and those exposed to CTM (63.37). Significant difference was also established in the post-test mean scores of students exposed to CSIP (X = 82.87) and those exposed to CTM (X = 63.37).

Hypothesis Two: There is no significant difference in the mean achievement scores of male and female students exposed to CSIP.

To test this hypothesis, t-test statistics were used to analyze the mean scores. The summary of this analysis is shown on Table 4.

Table 4: t-test analysis on achievement scores of male and female students exposed to CSIP

Variable	N	df	Mean(±)	SD	t-value	p-value
Male	15		83.60	3.23		
Female	15	28	82.13	3.25	1.24ns	0.23

ns: not Significant at 0.05 level

Table 4 presents the t-test analysis of male and female students in CSIP group. The mean score of the male students is 83.60 and 82.13 for the females. The t-value of 1.241 was not significant at a 0.05 level. This indicates that there is no significant difference between the male and female students taught with CSIP (t = 1.24, df = 28, p = 0.23). Hence, Ho_2 was upheld. Therefore, there is no significant difference between male and female students taught using the computer simulation instructional package.

Hypothesis Three: There is no significant difference in the mean scores of male and female students exposed to CTIP. To test this hypothesis, t-test statistics was also used to analyze the mean scores. The summary of this analysis is shown in Table 5.

Table 5: t-test analysis on achievement scores of male and female students in CTIP group

Variable	N	df	Mean(±)	SD	t-value	p-value
Male	15		77.20	4.46		
Female	15	28	75.07	3.77	1.42 ns	0.17

ns: not Significant at 0.05 level

Table 5 presents the t-test of male and female students of CTIP group. The mean scores of the male students were 77.20 and male 75.07 for the female students. The t-value of 1.42 was not significant at the 0.05 level. This indicates that there was no significant difference between the male and female students taught using CTIP, (t = 1.42, df = 28, p = 0.17). Hence, Ho_3 was upheld. Therefore, there is no significant difference between male and female students taught using computer tutorial instructional package.

Hypothesis Four: There are no significant differences in the intrinsic motivation of students taught chemistry using CSIP, CTIP and CTM. To determine whether there were significant differences in the post-test mean scores of the CSIP, CTIP and CTM groups, data was analyzed using the analysis of variance (ANOVA). Table 6 shows the result of the analysis.

Table 6 shows the pre-survey result of ANOVA comparing two experimental groups and control group. From Table 6, the F-value (2.51, p = 0.09) was not significant at a 0.05 alpha level. This implies that there was no significant difference among the mean scores of the CSIP, CTIP and CTM groups at a 0.05 level of significance.

Also the results presented in Table 6 show the post-survey result of ANOVA comparing two experimental groups and control group. From the table, the F-value (153.25, p = 0.00) was significant at a 0.05 alpha level. This indicates that a statistically significant difference was established among the experimental groups and control group. Hence, the null hypothesis four (Ho_4) was rejected. Based on the established significant difference in the post-survey scores of the groups, Scheffe's test was used for post-hoc analysis. The results of this post-hoc analysis are as shown in Table 7.

The result in Table 7 indicates that there was significant difference in the post-survey mean scores of students exposed to CSIP (X = 3.74) and those exposed to CTIP (X = 3.17). It indicates significant differences in the post-survey mean scores of students exposed to CTIP (X = 3.17) and those exposed to CTM (X = 1.78). A significant difference was also established in the post-survey mean scores of students exposed to CSIP (X = 3.74) and those exposed to CTM (X = 1.78).

Table 7: Scheffe's post-hoc analyses of the groups mean scores

Groups	*Mean scores*	*CSIP*	*CTIP*	*CTM*
CSIP	3.74		*0.00	*0.00
CTIP	3.17	*0.00		*0.00
CTM	1.78	*0.00	*0.00	

* The mean difference is significant at the 0.05 level.

Hypothesis Five: There are no significant differences in the extrinsic motivation of students taught chemistry using CSIP, CTIP and CTM. To determine whether there were significant differences in the post-test mean scores of the CSIP, CTIP and CTM groups, data was analyzed using the analysis of variance (ANOVA). Table 8 shows the result of the analysis

Table 8 shows the pre-survey result of ANOVA comparing two experimental groups and control group. From the Table, the F-value (0.19, p =

Table 6: ANOVA pre-test and posttest on CSIP, CTIP and CTM groups

Test	*Source of variables*	*Sums of square*	*df*	*Mean square*	*F-value*	*p-value*
	Between groups	0.37	2	0.19	2.51ns	0.09
Pre-motivation	Within groups	6.48	87	0.07		
	Total	6.86	89			
	Between groups	60.90	2	30.45	153.25*	0.00
Post-motivation	Within groups	17.29	87	0.11		
	Total	78.1	89			

* The mean difference is significant at the 0.05 level

Table 8: ANOVA pre-test and posttest on CSIP, CTIP and CTM groups

Test	*Source of variables*	*Sums of square*	*df*	*Mean square*	*F-value*	*p-value*
	Between groups	0.04	2	0.02	0.19ns	0.83
Pre-motivation	Within groups	10.34	87	0.12		
	Total	10.38	89			
	Between groups	50.99	2	25.50	119.44*	0.00
Post-motivation	Within groups	18.57	87	0.21		
	Total	69.57	89			

ns: Not Significant at 0.005 level *Significant at 0.05 level

0.83) was not significant at a 0.05 alpha level. This implies that there was no significant difference among the mean scores of the CSIP, CTIP and CTM groups at a 0.05 level of significance.

Table 8 shows the post-survey result of ANOVA comparing two experimental groups and control group. From Table 8, the F-value (119.44, p = 0.00) was significant at a 0.05 alpha level. This indicates that a statistically significant difference was established among the experimental groups and control group. Hence, the null hypothesis five (Ho_5) was rejected. Based on the established significant difference in the post-survey scores of the groups, Scheffe's test was used for post-hoc analysis. The results of this post-hoc analysis are as shown in Table 9. The result in Table 9 indicates that there was significant difference in the post-survey mean scores of students exposed to CSIP (X = 3.42) and those exposed to CTIP (X = 2.97). It indicates significant difference in the post-survey mean scores of students exposed to CTIP (X = 2.97) and those exposed to CTM (1.64). Significant difference was also established in the post-survey mean scores of students exposed to CSIP (X = 3.42) and those exposed to CTM (X = 1.64).

Table 9: Scheffe's post-hoc analyses of the groups mean scores

Groups	*Mean scores*	*CSIP*	*CTIP*	*CTM*
CSIP	3.42		0.00*	0.00*
CTIP	2.97	0.00*		0.00*
CTM	1.64	0.00*	0.00*	

* The mean difference is significant at the 0.05 level

In addition to the achievement and motivational tests, which was used to assess the learners' knowledge and motivational strategy when learning periodic table and balancing of the chemical equations, an interview guide was conducted for 5 students in each of the groups. This enabled the researchers to gain a deeper understanding of the students' motivational strategy when learning chemistry. Students in the CSIP and CTIP groups who were taught chemistry using computer simulation instructional package and computer tutorial instructional package, respectively were asked about how they enjoyed their learning as against learning in their normal traditional method of learning.

Three themes, namely, preference, engagement and confidence were identified from both interview and classroom observations of the experimental groups and one or two quotations are presented on each of them below.

Preference: One of the questions the researchers asked the students in the interview guide was that learners should tell them whether they enjoyed learning the chemistry based on the just completed lesson when they used computer simulation instructional package. The vast majority of the learners reported that they liked the concept of balancing the given equation on the screen by adding coefficients so that the equation is balanced correctly. For instance, one learner commented that: *using computer simulation, I was able to count the number of molecules on right hand and that of left hand. If they are equal then I know the equation is balanced.*

Based on all the students' responses regarding their experience of learning with computer simulations, the researchers can say clearly that they preferred trying out things on their own instead of the teacher telling them or writing the balanced equation for them as would be the case if computer simulations were not integrated in the teaching and learning process.

Engagement: The classroom observations of the students in the experimental group I and the students' response to the question on what they think about their accomplishment by learning chemistry using computer simulation provide confirmatory evidence of the students' engagement during learning processes. Of particular note is their use of the computer simulation to balance the equation easily and with excitement. The researchers' classroom observation notes show that students in the experimental group I especially were engaged with the learning activity throughout the period of the study compared to the other two groups. Perhaps this is because, as one of the students interviewed noted, the use computer simulation makes the activities seem more like what "real scientists do". As another student commented, *"It's really fun. It's nicer than the traditional method."*

Confidence: Learners were asked if and how a computer could make difficult concepts easy for them to understand. In their responses, most of the learners agreed that a computer could make difficult concepts simple and easier to understand. They also explained that the manner in which a computer presents concepts is fascinating and because of its multi-functionality it can combine sound and visual aspects. Learners explained that seeing the movement of molecules in the form of moving pictures and text actually eliminate the abstractness of concepts and present a virtual reality, which makes complex concepts seem simple. They remarked that, *"Computer simulations are very wonderful and exciting because one can visibly see the pictures and the text on the screen at the same time"*.

In the case of the control group, only one theme was identified, that is, both periodicity and balancing chemical equations were difficult. All the learners indicated that periodicity and balancing chemical equations were difficult for them to understand. Finally, learners in the control group confessed that chemistry was boring to them and that there was no way it could be easily understood.

In summary, findings show that the use computer simulations can increase student motivation and engagement in learning, especially their motivation towards exploring difficult concepts on their own.

DISCUSSION

This present study investigates the influence of computer-assisted instruction towards promoting intrinsic and extrinsic motivation as well as the learners' achievements when learning chemistry. Since the learners' understanding of both, the periodic table and balancing of the chemical equation concepts was established from the pre-tests, which was administered to all the groups, any difference in the achievement and the motivational strategy should be accounted to the computer simulations and computer tutorial, which were only utilized in the two experimental groups. Results show that there was no statistically significant difference between the performance of the two experimental groups and control group in the pre-test (F-value (1.066, $p = 0.349$) (Table 2), implying that the three groups were similar.

Therefore, results of hypothesis one reveal that there was a significant difference in the learning achievements of those taught chemistry concepts with computer simulation, computer tutorial and traditional method in favor of computer simulation and tutorial, respectively.

This result agrees with the findings of Akpan and Andre (2000), Winberg and Headman (2007) and Saminathan (2012) who found computer simulation instructional strategies to be an effective teaching strategy than the traditional method of teaching chemistry. However, the findings disagree with earlier findings of Winn et al. (2007), which reported that the use of computer simulations to be less effective than traditional instruction and hands-on laboratory approaches.

This result also agrees with the findings of Badmus (2007), Egunjobi (2004), Kara and Yesilyurt (2007), Yaakub and Finch (2001), which revealed the effectiveness of computer tutorial mode over the traditional method in classroom setting across different disciplines at secondary schools level both in Nigeria and outside Nigeria. However, it disagrees with the finding of Ramanchandram and Scottler (2003), which found no significant difference between the traditional method and tutorial mode on achievement.

The results of hypothesis two and three show that there is no gender effect on the achievement of male and female students taught chemistry concepts with computer simulation and tutorial modes. This finding is in agreement with the results of Adesoji and Babatunde (2005), Gambari (2004), Fagbemi et al. (2012) who found that male and female students performed equally well in chemistry, biology, physics and social studies using computer-based instructional packages.

The results of hypothesis four showed significant differences in the intrinsic motivation of students taught chemistry using computer simulation, tutorial and conventional traditional method in favor of simulation and tutorial, respectively. This finding is in agreement with the results of Winn et al. (2006) who reported that intrinsically motivated students are more likely to persist with challenging tasks and other positive classroom behaviors as well as performs better academically.

The results of hypothesis five showed significant differences in the extrinsic motivation of students taught chemistry using computer simulation, tutorial and conventional traditional method in favor of simulation and tutorial, respectively. This finding is in line with the results of Glynn et al. (2009) who found that when college students reported lower motivation in science courses their performance was lower as well. Similarly, Moos (2010) found that participants who had high extrinsic and high intrinsic motivation significantly outperformed those who had low extrinsic and low intrinsic motivation. This finding positively correlated to the performance of students exposed to simulation and tutorial, respectively.

Responses of the learners to the interview questions as well as the classroom observations suggest how chemistry concepts could best be taught to the learners in order to simplify learning. In response, all the learners from the CSIP group indicated that chemistry should be taught using computer simulations in addition to computer tutorials. Overall learner assessments in the CSIP group suggested that lessons were very interesting, exciting and educative. This in a way could explain why learners in the CSIP outperformed those in the CTIP and CTM groups on both achievement and motivational tests. Recent studies conducted by Hwang et al. (2011), Farhana and Zainun (2012) and Ercan (2014) showed that using computer multimedia applications for learning chemistry increased the students' performance in the subject and it enabled them to develop a positive attitude towards learning science subjects. The studies further emphasized that when students are using multimedia applications they can participate more in the learning processes than using conventional methods of teaching and learning.

In this present study, learners exposed to computer simulations performed best on chemistry achievement and motivational tests when compared to those taught without computer simulations. This therefore confirms the effectiveness of computer simulations. While the teachers may find it difficult to explain certain facts to the learners, computer simulations provide simplified explanations that can be easily followed by the learners. Based on the fact that learners find learning with computer simulation easier and interesting, learners in a way became highly motivated towards learning chemistry as a subject in the school.

CONCLUSION

The study investigated how intrinsic and extrinsic motivation could enhance achievement in Chemistry among the senior secondary school students using computer simulation instructional package and computer tutorial instructional package. Computer simulation and computer tutorial were found to enhance both intrinsic and extrinsic motivation. Students exposed to computer simulation have higher extrinsic and intrinsic motivation than their counterpart in computer tutorial and conventional method, respectively. Results show that computer simulation and computer tutorial were found to enhance learning achievement as well as intrinsic and extrinsic motivation. In addition, the results of his study show that the use of technology in the classroom is gender sensitive, this means that both male and female students achieved equally with the use of technology like computer simulation. These have implications to the curriculum planners such that when they are designing the curriculum they should plan for active involvement and use of simulations in the curriculum. With the use of computer simulation and the fact that students enjoyed new concepts, which were applicable to the real life situation, can explain their improved performance in CAT as well as their positive attitude towards learning chemistry.

RECOMMENDATIONS

In view of the positive results obtained from this research, it is therefore recommended that teachers should be ICT compliant in order to cope with current trends in pedagogical practices and institution needs to expand their network. Science teachers and teachers from other disciplines should be trained on the effective use of computer for instruction through seminars, workshops and conferences. Teachers can be asked to take part in in-service training on how to integrate various technological tools into teaching and learning processes in order to be able to enhance their students' learning especially in abstract subjects like chemistry. Moreover, computer simulation and tutorial instructional strategies should be used to bridge the academic gaps that might exist between male and female science students. Students are likely to perform better if they are intrinsically and extrinsically motivated. Therefore, the use of computer simulation and tutorial should be used to increase the students' motivation and enhance their active participation in the classroom. Finally, in order to be able to generalize the findings of this research, studies using subjects other than science to confirm or refute the findings on the use of computer simulation are highly recommended.

REFERENCES

Achuonye KA 2011. Using computer in science class: The interactive effect of gender. *Journal of African Studies and Development,* 3(7): 131-134.

Adegoke BA 2011. Effect of multimedia instruction on senior secondary school students' achievement in Physics. *European Journal of Educational Studies*, 3(3): 537-541.

Adesoji FA, Babatunde AG 2005. Expressive teaching behaviour: Bridging the gender gulf in secondary school chemistry achievement. *International Journal of African and African American Studies,* 4(1): 54-61.

Akpan JP, Andre T 2000. Using a computer simulation before dissection to help students learn anatomy. *Journal of Computers in Mathematics and Science Teaching,* 19(3): 297-313.

Akram M, Athar HM, Ali M 2011. The influence of computer assisted instruction (CAI) in chemistry on the students' achievement at higher secondary level. *Journal of Social Sciences and Education,* 1(4): 426-435.

Anagbogu MA, Ezeliora B 2007. Sex differences and scientific performance. *Women Journal of Science and Technology,* 4(1): 10-20.

Arwood L 2004. Teaching cell biology to non-science majors through forensics, or how to design a killer course. *Cell Biology Education,* 3(2): 131–138.

Badmus AM 2007. *Effect of Practical Demonstration Method (PDM) and Computer Tutorial Mode (CTM) on Students' Achievement and Attitudes in Some Selected Skills in Technical Education*. MA Thesis, Unpublished. Nigeria: University of Ibadan.

Braun V, Clarke V 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2): 77-101.

Britner SL, Pajares P 2006. Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching,* 43(5): 485-499.

Burns C, Myhill D 2004. Interactive or inactive? A consideration of the nature of interaction in whole class teaching. *Cambridge Journal of Education,* 34(1): 35–49.

Carmelita YR 2008. A comparison of computer-assisted instruction and the traditional method of teaching basic statistics. *Journal of Statistics Education,* 16(1): 1-10.

Cavallo AML, Potter WH, Rozman M 2004. Gender differences in learning constructs, shifts in learning constructs, and their relationship to course achievement in a structured inquiry, yearlong college physics course for life science majors. *School Science and Mathematics,* 104(6): 288–300.

Covington MV 2000. Goal theory, motivation and school achievement: An integrative review. *Annual Review of Psychology,* 51(2): 171-200.

Doering A, Veletsianos G 2009. Teaching with instructional software. In: MD Roblyer, A Doering (Eds.): *Integrating Educational Technology into Teaching.* Upper Saddle River, NJ: Pearson Education, pp. 73-108.

Efe HA, Efe R 2011. Evaluating the effect of computer simulations on secondary biology instruction: An application of Bloom's taxonomy. *Scientific Research and Essays,* 6(10): 2137-2146.

Egunjobi AO 2004. *The Relative Effectiveness of Computer-Assisted Instructional Modes on Students Learning Outcomes in Geography.* MA Thesis, Unpublished. Nigeria: University of Ibadan.

Emeke EA, Adegoke BA 2001. The Interaction Effect of Test Response Mode, Students' Numerical Ability and Gender on Cognitive Achievement in Senior Secondary School Physics. From <findarticles.com/p/articles/m-993765/is_200611/…/pg2> (Retrieved on 20 August 2013).

Ercan O 2014. The effects of multimedia learning material on students' academic achievement and attitudes towards science courses. *Journal of Baltic Science Education,* 13(5): 608-621

Fagbemi PO, Gambari AI, Oyedum NA, Gbodi EB 2011. Effects of computer-assisted instructional package on social studies achievement among senior primary school pupils in Niger State, Nigeria. *Journal of Science, Technology, Mathematics and Education,* 7(2): 204-214.

Federal Republic of Nigeria 2004. *National Policy on Education*. Lagos: Federal Government Press.

Federal Republic of Nigeria (FRN) 2008. *National Policy on Education.* Lagos: Federal Government Press.

Gambari AI 2004. *Effects of Computer-assisted Instruction Package on the Performance of Senior Secondary Students in Physics in Minna*. MTech Thesis, Unpublished. Minna: Federal University of Technology.

Gambari AI, Falode OC, Fagbemi PO, Idris B 2012. Effect of Virtual Laboratory Strategy on the Achievement of Secondary School Students in Nigeria. *Proceedings of the 33rd Annual Convention and National Conference of Nigeria Association for Educational Media and Technology (NAEMT)* held at Emmanuel Alayande College of Education, Oyo, Oyo State. October 8-13.

Gambari AI, Yaki AA, Gana ES, Ughovwa QE 2014. Improving secondary school students'achievement and retention in biology through video-based multimedia instruction. *IJSSE,* 4(2): 79-91.

Garcia T 1993. Women and Minorities in Science: Motivational and Cognitive Correlates of Achievement. *Paper presented at the Annual Meeting of the American Educational Research Association.* Atlanta, GA, April 12-16, 1993.

Glynn SM, Koballa TR 2006. Motivation to learn in college science. In: JJ Mintzes, WH Leonard (Eds.): *Handbook of College Science Teaching.* Arlington, VA: National ScienceTeachers Association Press, pp. 25–32.

Glynn SM, Taasoobshirazi G, Brickman P 2007. Non-science majors learning science: A theoretical model of motivation. *Journal of Research in Science Teaching*, 44(8): 1088–1107.

Glynn SM, Taasoobshirazi G, Brickman P 2009. Science motivation questionnaire: Constructvalidation with non-science majors. *Journal of Research in Science Teaching,* 46(2): 127-146.

James T 2001. *Effect of Combining Reflective Writing with Concept Mapping and Lecture Method on Preservice N. C. E Teacher's Attitude and Achievement in Biology*. PhD Dissertation, Unpublished. Zaria: Ahmadu Bello University.

Jegede SA 2007. Student's anxiety towards the learning of chemistry in some Nigerian secondary schools. *Educational Research and Review,* 2(7): 193-197.

Kara Y, Yesilyurt S 2007. Assessing the effects of tutorial and edutainment software programs on students' achievements, misconceptions and attitudes towards biology. *Asia-Pacific Forum on Learning and Teaching,* 8(2): 1-22.

Kaufman J, Agars M, Lopez M, Wagner M 2008. Examining creativity in Turkey High Ability Studies. *Journal of California State University,* 18(2): 235-246.

Lin YG, McKeachie WJ, Kim YC 2002. College student intrinsic and/or extrinsic motivation and learning. *Learning and Individual Differences,* 13(1): 251-258.

Momsen J, Offerdahl E, Kryjevskaia M, Montplaisir L, Anderson E, Grosz N 2013. Using assessments to investigate and compare the nature of learning in undergraduate science courses. *CBE Life Sci Educ,* 12(2): 239-249.

Moos DC 2010. Nonlinear technology: Changing the conception of extrinsic motivation *Computers and Education,* 55(4): 1640-1650.

Nadelson LS, Scaggs J, Sheffield C, McDougal OM 2015. Integration of video-based demonstrations to prepare students for the organic chemistry laboratory. *Journal of Science Education and Technology,* 24: 476-548.

Olorukooba SB 2007. Science, Technology and Mathematics (STM) Education is For All Students: Promoting Effective Teaching of STM Subjects in Our Schools Through Teacher Preparation. *Proceedings of the 50th Anniversary Conference of Science Teachers Association of Nigeria,* Ibadan, Nigeria. August, 5-7, 2007, pp. 3-6.

Ryan RM, Deci EL 2000. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology,* 25(1): 54-67.

Saminathan B 2012. Effect of Computer- based Instructional Strategies in Learning Chemistry at Higher Secondary Level. *International Conference on Software and Computer Applications (ICSCA 2012).* Singapore. June 9-10, 2012. *IPCSIT vol. 41 (2012)* © (2012) IACSIT Press, Singapore

Trey L, Khan S 2008. How science students can learn about unobservable phenomena using computer based analogies. *Computers and Education,* 51(2): 519-529.

Tüysüz C 2010. The effect of the virtual laboratory on students' achievement and attitude in chemistry. *International Online Journal of Educational Sciences,* 2(1): 37-53.

WAEC 2012. May/June. *Chief Examiner's Report*. Lagos: Research and Statistics Unit, WAEC.

Walker CO, Greene BA, Mansell RA 2006. Identification with academics, intrinsic/extrinsic motivation, and self-efficacy as predictors of cognitive engagement. *Learning and Individual Differences,* 16(1): 1-12.

Wasagu MA, Muhammad R 2007. Female Education in Science, Technology and Mathematics and Sustainable Development in the New Millennium. *50th Annual Conference Proceeding of STAN,* Ibadan, Nigeria. August 5-7, 2007, pp.86 - 88.

Watson M, McSorley M, Foxcroft C, Watson A 2004. Exploring the motivation and learning
strategies of first year university learners. *Tertiary Education and Management,* 10(3): 193-207.

West African Examination Council (WAEC) 2003-2012. *Examiners Report in Science Subjects.* Lagos: WAEC.

Winberg TM, Headman L 2007. Student attitudes toward learning, level of pre-knowledge and instruction type in a computer- simulation: Effects on flow experiences and perceived learning outcomes. *Springer Sci Bus Media BV,* 36: 269-287.

Yaakub M, Finch C 2001. Effectiveness of computer-assisted instruction in technical education: A meta-analysis. In: J Kapes (Ed.): *Occupational Education Forum/Workforce Education Forum (OEF/WEF),* 28(2): 5-19.

Yu SL 1999. Women's motivation and strategy use in college science classes. *Journal of Staff, Program, and Organization Development,* 16(1): 93-101.

Yusuf MO, Afolabi AO 2010. Effects of computer assisted instruction (CAI) on secondary school students' performance in biology. *The Turkish Online Journal of Educational Technology,* 9(1): 62-69.

Zeegers P 2001. Approaches to learning in science: A longitudinal study. *British Journal of Educational Psychology,* 71(1): 115-132.