Effects of Computer-Assisted Instruction and Concept Mapping on the Academic Achievement of Students with Hearing Impairment in Ecology in Ibadan, Oyo State, Nigeria

Olufemi, T. A.
Department of Special Education,
University of Ibadan, Ibadan
oluphemmy54@yahoo.com

Abstract
This study investigated the effects of computer-assisted instruction (CAI) and concept mapping (CM) on the academic achievement of students with hearing impairment (SHI) in ecology in Ibadan, Oyo State, Nigeria. Three hypotheses were generated for the study while the pretest-posttest, control group quasi-experimental research design was adopted for the study. The treatment was cross examined with gender and academic self-efficacy among students with hearing impairment for a period of 8 weeks. The Ecology Achievement Test (EBAT, r = 0.67) and the Academic Self-efficacy Questionnaire (ASEQ, α =.79) was used for data collection. Data generated were analysed with Analysis of Covariance (ANCOVA) at $p<0.05$. Results revealed a significant main effect of treatment on the achievement of SHI in ecology; no significant interaction effect of gender and academic self-efficacy on the achievement of SHI in ecology and no significant interaction effect of treatment, gender and academic self-efficacy on the academic achievement of SHI in ecology. The study concluds that both CAI and CM have positive effect on the academic achievement of SHI in ecology but CAI has the highest significant effect on the participants. Based on the findings, it is recommended that biology and other science subject should be taught to SHI using self-learning, engaging and technologically appealing computer-mediated approach such as the CAI.

Keywords: Computer-assisted instruction, concept mapping, ecology, hearing impairment

Introduction

It has been observed in recent times that the role environment plays in a nation's development process cannot be over emphasized. Environment represents a wide range of external circumstances, conditions and the things that affect the existence and development of an individual, organism or group. However, there is now a wide appreciation of the damages being done to the environment through human activities. Researchers such as Aja (2005); Omofonmwan and Osa-Edoh (2008); Ikitde and Edet (2013) have associated environmental pollution with human activities and albeit persistent human interaction with the environment. More so, with attendant pressure on environment especially in the wake of improved technologies, environmental abuse and pollution is nevertheless heightened with corresponding effects on lives of persons with or without hearing impairment and other living organisms.

Persons with hearing impairment whose disability becomes evident in the context where communicative skills are needed, such individuals may grossly lag behind in the knowledge of keeping environment safe for the future by resolving fundamental issues relating to the current and future use of the world's resources. In other words, the absence or loss of hearing has a pervasive influence on an individual and the primary disability is communication difficulties; both receptive and expressive communication. Students with hearing impairment are heterogeneous group comprising of diverse and complex psychosocial characteristics, which have a significant impact on learning outcomes. According to Nikolaraizi and Theofanous (2012, students with hearing loss are often brought up in the environment where they have a limited access to language, reading and world experiences. Therefore, they develop poor schemata that affect negatively their ability to derive the meaning of a text especially in intermediate or higher grades when texts become scriptually implicit. So far, their understanding requires more background information. Based on this, it has been a point of call to stakeholders to educate their citizens irrespective of disabilities and create awareness through all channels of communication about the

fundamental knowledge of the environment and the tool to manage it effectively. This call for environmental education is hinged on the belief that having basic knowledge of science, its skills and process can improve the quality of life of persons with or without hearing impairment and increase the survival rate of the human race.

In search for a solution to solving environmental problems, ecology holds a unique place in this regard because it is the scientific study of life. Ecology is concerned with life and its processes and a good grasp of biological principles is necessary for human survival. In other words, ecology provides students with an understanding of the structure of living organisms and the relationship of these organisms with their immediate environment. Indeed, environmental ecology has received a lot of attention in recent times. More attention has come especially in the light of renewed campaign worldwide geared towards controlling and improving environmental problems to the survival of human race. A cursory look at the Nigeria situation reveals the need to educate everyone including students with hearing impairment about the environment, which suffers abuse on a daily basis.

In ensuring a safe environment devoid of pollution in Nigeria, the National Educational and Research Development Council (NERDC, 1994) and the National Policy on Education (FRN, 2004) have recognized and drawn up guidelines for the incorporation of ecological issues into the biology curriculum of the senior secondary school programmes. According to Ige (1998), ecology in the secondary school curriculum is one of the most interesting topics. However, teachers of students with hearing impairment rarely teach such topics because of difficulties associated with how to teach and explain some of the ecological concept, however, students with hearing impairment performs poorly in biology when they sit for the Senior Secondary Certificate Examination (SSCE). The chief examiner's report of the West African Examination Council (WAEC) in 2010 as well as Abimbola and Abidoye (2013) observed that there is an increasing yearly enrolment in science subject especially biology.

However, the performance of students including those with hearing impairment in the Senior School Certificate Examinations (SSCE) continues to decline. Research on problems of teaching environmental concepts in secondary schools in Nigeria according to Adu and Sheyin (2014) revealed that inadequacy of resources for teaching ecology, teachers' unsatisfactory use of resources and unsatisfactory performance in practical and field work were some of the factors militating against effective learning outcomes in biology. Ige (1998) and Sangodoyin (2011) as one of the causes of students' dismal performance in biology observed poor teaching method. Dismal performance was particularly noted in ecology. Based on the observation, conventional method of teaching, which involves the chalk-talk principles are not adequate and suitable for the teaching of environmental concept to students with hearing impairment in the 21st century classroom. The reason is that they have poor language skills with reduced opportunity for incidental learning. Therefore, they tend to be effective when used with visual, tactile and stimulating instructional materials that could compensate for the loss in sense of hearing.

Teaching sciences to students with hearing impairment require a series of influential teaching approaches in ways that promote meaningful learning, problem solving, and critical thinking for a diversity of students to increase motivation and achievements and to protect them against the negative effects of the rote-memory based educational system. All around the world, educators are becoming more aware of new teaching strategies and tools. Strategies and tools that can be used in the classroom with initiatives in teaching-learning that integrates the inquiry based learning with information communication technology, audio-visual interactivity packages, visual models using the Computer-Assisted Instruction (CAI) and Concept Mapping (CM) instructional strategies in an effort to aid learning. CAI is an instruction or remediation presented on a computer to illustrate a concept through attractive animation, sound, and demonstration (Yenice, 2006). CAI can be referred to as a self-learning technique usually offline/online, involving interaction of students with programmed instructional materials. Studies

conducted by researcher on the application of CAI on the learning outcome of students have revealed diverse results. For example, Muraina, Adeleke and Rahman (2011) examined the effect of computer-assisted instructional method on students' performance in the introduction to computer science and electronic data processing courses.They concluded that using computer-assisted instructional method does have significant effect on students' performance than conventional teaching method. That enforcing teachers to embrace it, are ways of increasing the educational value, promoting learning and providing students with good experiences.

Christina *et al*. (2006) studied the behavioural improvements associated with computer-assisted instruction for children with developmental disabilities using a pre-test/post-test design to determine acquisition of the targeted concepts using the computer software for all eight participants. The study of Christina *et al*. (2006) demonstrated that children with autism and other developmental disorders were able to learn receptive language, social and cognitive skills via CAI using the teachtown software program. These data were consistent with previous studies indicating that CAI is effective for teaching receptive language skills (Moore and Calvert, 2000). owever, Ahiatrogah, *et al*. (2013) found no significant difference between CAI and traditional groups on their achievement in Adhesives, a topic in pre-technical skills. They had compared the effects of CAI on the achievement of 59 junior high school students in pre-technical skills after exposing them to CAI and the traditional methods of instruction.

In a similar vein, concept mapping (CM) is an instructional tool that is currently gaining popularity in the field of science education. Bello and Abimbola (1997) noted that concept mapping is a product of recent advances in cognitive science and the new philosophy of science. Contemporary perspectives of cognitive psychologists and the new philosophers of science on cognition view learning as an active internal process of construction where the learner's prior knowledge plays a significant role in further conceptual learning (Ausubel, 1968; Ausubel and Hewson, 1986 and Novak, 1991).

Kinchin (2000) discussed the positive impact of using concept maps on instruction and learning in secondary biology education. Building on the researches earlier conducted, Kinchin (2000) demonstrated the relevance of concept mapping for teacher planning and preparing a lesson as well as creating an opportunity for meaningful learning on behalf of students. Kinchin (2000) observed a positive effect on students who used concept maps to revise and summarize the material. The study of Akeju *et al***.** (2011) among a sample of 168 senior secondary school class-II physics students in Ekiti State, Nigeria, revealed that there is a significant effect of concept mapping instructional strategy on students' learning achievement.

Udeani and Okafor (2012) studied the comparative effectiveness of the expository and concept mapping instructional strategy of presenting secondary school biology concepts to slow learners using one hundred and twenty four biology slow learners. They were identified and randomly assigned to the expository group and concept-mapping group. The groups were post-tested after two weeks of teaching for any significant differences in their biology achievement. The analysis of post-test scores indicated that the group taught by the concept mapping instructional strategy performed significantly better than their expository group counterparts did. This finding was in accord with the findings of previous studies (Okebukola, 1990; McClure *et al*.1999; Zantinget *et al*. 2003 and Safayeni *et al*. 2005) which provided evidence attesting to the efficacy of concept mapping in facilitating meaningful learning among students irrespective of gender. Although, gender is one of the factors interacting with achievement in biology and other science subjects (Isa, 2005 also Ekwueme andUmoinyang, 2005) studies on how gender actually influences achievement are inconclusive. Some studies (Ifeako, 2005and Obeka, 2007) show that male students have higher achievements and interest scores in chemistry than females. This was attributed to sex-role stereotyping, masculine image of science and female socialization process. Contrary to the above findings, Ekwueme and Umoinyang (2005) reported that gender influenced achievement in favour of females. On the contrary, Danmole and Femi-Adeoye (2004) found no significant difference in

the achievement of students due to gender. Danmole and Femi-Adeoye (2004) revealed that achievement of both males and females can be affected by teaching and learning styles. It is based on this premise that this study examined the influence of gender on achievement in environmental concepts. According to Lagoke *et al*. (1997), the important factors that develop gender difference are sex role identification, culture and socialization. Boujaoude and Attieh (2003) reported better performance of female students in science subjects.

Irrespective of gender, a good academic performance is expected to be exhibited by a student after a period of study. Such academic performance may however be influence by students' self-efficacy. Self-efficacy is the individuals' assessment of their capabilities to organize and execute actions required to achieve successful levels of performance (Bandura, 1986). Hence, students' beliefs in their efficacy to regulate their own learning and to master academic activities determine their aspirations, level of motivation and academic accomplishments. Increased self-efficacy is accompanied by enhanced intrinsic motivation, the ability to sustain high levels of motivation and achievement oriented behaviour, persistence in the face of difficulties, and better problem solving (Bandura, 1997). Numerous studies demonstrate that efficacy beliefs are influenced by the acquisition of cognitive skills. However, they are not solely the reflection of them. For example in 1995, Compeau and Higgins developed and validated a 10-item instrument of computer self-efficacy (CSE) and identified that computer self-efficacy had a significant influence on computer-use outcomes, emotional reactions to computers, and actual computer use. Madorin and Iwasiw (1999) studied the effects of computer-assisted instruction on the self-efficacy of baccalaureate nursing students. The researchers used a nonprobability, convenience sample of second-year baccalaureate nursing students who were assigned randomly to experimental and control groups. The findings by Madorin and Iwasiw (1999) showed that a higher preclinical self-efficacy scores ($p<.01$) of the experimental group support the use of CAI as an important aspect of clinical education. This finding corroborates the assertion of Akçay *et*

al. (2006) who noted that CAI is a method that uses computers in a learning media to strengthens students' motivation, self-efficacy and educational processes.

Chularut and DeBacker (2004) studied the effect of concept mapping on academic achievement; self-efficacy and self-regulation of students in English classes as a second language was investigated among Seventy-nine ESL students using a randomized pretest-posttest control group design. The findings showed a statistically significant interaction of time, method of instruction, and level of English proficiency for self-monitoring, self-efficacy, and achievement. Similarly *et al*. (2013) investigated if concept mapping as a cognitive tool could contribute to improving self-regulation of students in a reading course. To fulfill the aim of the study, sixty university students from one of the universities in Iran were randomly assigned to two groups: one experimental (concept mapping) and the other control (conventional method). The results from the study of Khajavi and Abbasian (2013) revealed a significant difference between the two groups. The students in the experimental group out performed those in the control group on self-regulation in reading.

However, there are studies on CAI and CM with consideration to those students with hearing impairment. Students who have difficulty to expressing and understanding some basic biological and environmental concepts due to their inability to respond to auditory-verbal stimulus and little access to the regular curriculum of science. That happens so because majority of their teachers are lacking in the required sign language skills to effectively explain scientific concepts to them via sign language. Therefore, this study examined the effects of computer-assisted instructions and concept mapping on achievement in ecology among students with hearing impairment in Ibadan. The study sought to determine the moderating effects of gender and academic self-efficacy on the achievement in ecology among students with hearing impairment in Ibadan, Oyo State, Nigeria.

Hypotheses

HO_1. There is no significant main effect of treatment on the achievement of students with hearing impairment in ecology.

HO_2. There is no significant interaction effect of gender and academic self-efficacy on the achievement of students with hearing impairment in ecology.

HO_3. There is no significant interaction effect of treatment, gender and academic self-efficacy on the achievement of students with hearing impairment in ecology.

Methodology

The study adopted the pretest-posttest, control group quasi-experimental research design using a 3x2x2 factorial matrix with treatment at three levels (Computer-Assisted Instruction, Concept Mapping and Control Group). The treatment was cross examined with gender and academic self-efficacy among students with hearing impairment at two levels respectively.

Table 3.1: 3x2x2 Factorial matrix for the study

Treatment	**Academic self-efficacy**		**Gender**	
	High	**Low**	**Male**	**Female**
Computer-Assisted Instruction	11	3	9	5
Concept Mapping	8	6	8	6
Conventional Method	4	9	6	7
Total	**23**	**18**	**23**	**18**

Participants

The participants were senior secondary school II students with hearing impairment who were purposively selected from three integrated special schools in Ibadan, Oyo State. This is because they were more stable, they were not preparing for examinations and they

had been exposed to some biological concepts. The researcher employed a simple random sampling technique to select participants for the Computer-Assisted Instructional Package and Concept Mapping Instructional Strategy.

Data Collection and Analysis

The Ecology Achievement Test (EBAT) and the Academic Self-efficacy Questionnaire (ASEQ) was used for data collection. The EBAT is a 50-item, 5-option multiple-choice objective test, developed and validated by the researchers based on following sub-topics: The ecosystem, functioning ecosystem, food chain, food web, pyramid of numbers as well as pyramid of energy. The reliability coefficients of the EBAT, was determined using the kuder-Richardson'sformula-20 (KR- 20) and the value obtained was 0.67.The Academic Self-efficacy Questionnaire (ASEQ) being a modified version of Morgan-Jinks students' self-efficacy scale (1999) used by Ogundokun (2007) and Awoyemi and Keshinro (2013) was used for this study. The scale is a 20-item questionnaire, which has a five-response format ranging from almost never to almost always. Some of the items of the scale read as follows: (1) I work hard in school, (2) I could get the best grades in class if I tried enough, Scores of 5, 4 and 3 indicates high self-efficacy while 2 and 1 indicate low self-efficacy. The reliability of thecademic self-efficacy scale was determined using Cronbach Alpha and it was found to be reliable at 0.79.

All participants (students with hearing impairment) were pretested on the first week with the Ecology Achievement Test (EBAT) and the Academic Self-efficacy Questionnaire (ASEQ). Participants were assigned to two experimental groups (Computer-Assisted Instruction and Concept Mapping) and control group and taught the same content for a period of six (6) weeks. The treatment session lasted for 90 minutes during each session. Participants in the control group were given a placebo treatment. In other words, they were taught using the conventional mode of teaching. They were encouraged to read their books always.The posttest was conducted on the eighth (8^{th}) week of treatment. Data generated were subjected to statistical

analysis using both the descriptive statistics as well as inferential statistics to determine the achievement of students with hearing impairment in ecology when exposed to Computer-Assisted Instruction and Concept Mapping instructional strategies. The inferential statistics of Analysis of Covariance (ANCOVA) was used to test the null hypotheses at $p<0.05$.

Results

Hypothesis 1: There is no significant main effect of treatment on the achievement of students with hearing impairment in ecology.

Source	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Eta Squared**
Corrected Model	490.414	12	40.868	6.113	.000	.724
Intercept	194.492	1	19492	29.091	.000	.510
Pre Achievement	.771	1	.771	.115	.737	.004
Main Effects:						
Treatment	297.142	2	148.571	22.223	.000	.614
Academic Self-Efficacy	15.232	1	15.232	2.278	.142	.075
Gender	15.365	1	15.365	2.298	.141	.076
2-way Interactions:						
Treatment x Academic Self-Efficacy	26.893	2	13.446	2.011	.153	.126
Treatment x Gender	34.817	2	17.409	2.604	.092	.157
Academic Self-Efficacy x Gender	1.415	1	1.415	.212	.649	.008
3-way Interactions	21.079	2	10.540	1.576	.225	.101
Error	187.196	28	6.686			
Total	5727.000	41				
Corrected Total	677.610	40				

The results from Table 1 above show that there was a significant main effect of treatment on the achievement of students with hearing impairment in ecology ($F_{(2,38)}$ =22.223, P<0.05; η^2 = 0.614). Therefore, the null hypothesis 1 is not accepted. This implies that the treatment has a significant main effect on achievement in ecology among participants with an effect size of 61.4%. To further establish and determine the actual source of the observed significant main effect in ANCOVA, a Scheffe Post Hoc Analysis was carried out on the posttest mean score of the three groups as presented in Table 2.

Table 2: Scheffe Post Hoc Multiple Comparison of the Mean Difference of Treatment and Control Groups on the achievement of Students with Hearing Impairment in ecology

(I) (J) Treatment Treatment Groups Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
				Lower Bound	Upper Bound
CAI	6.3571*	1.0213	.000	3.7555	8.9588
CAI	6.8132*	1.0407	.000	4.1620	9.4644
	-6.3510*	1.0213	.000	-8.9588	-3.7555
Control	.4560	1.0407	.909	-2.1952	3.1073
CM	-6.8132*	1.0407	.000	-9.4644	-4.1620
CM	-.4560	1.0407	.909	-3.1073	2.1952
Control					
Control					
CAI					
CM					

* The mean difference is significant at the .05 level.

Note: CAI = Computer Assisted Instructions

CM = Concept Mapping

The Post Hoc multiple comparisons in Table 2 show the performance of the participants in all the groups. The direction of decreasing main effect of treatment on the achievement of students with hearing impairment in ecology is computer assisted Instruction, concept mapping, control group. It further shows that computer Assisted Instructions was more significant than the concept mapping

instructional strategy among students with hearing impairment.

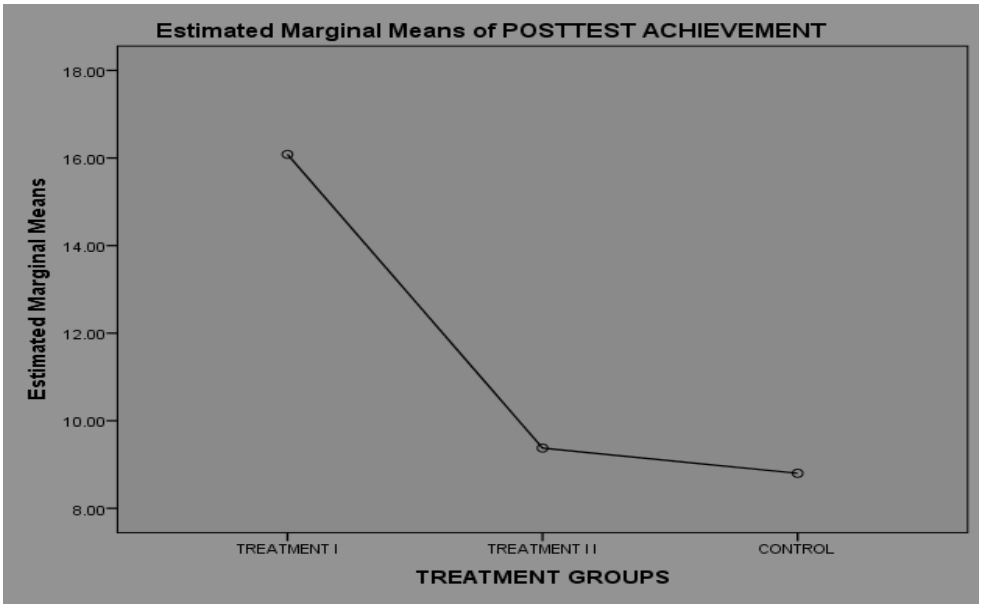

Figure 1: Estimated marginal mean scores of treatments and the control groups.

Figure 1 revealed that computer-assisted instruction had the highest mean value of 15.429 followed by concept mapping with a mean value of 9.071 while the control group had a mean score of 8.615. This implies that students in the computer-assisted instructional group had the highest contribution to observed significant difference in the treatment followed by the concept mapping instructional strategy and the least observed significant difference is from the control group.

Hypothesis 2: There is no significant interaction effect of gender and academic self-efficacy on the achievement of students with hearing impairment in ecology.

The results from Table 1 show that, there was no significant interaction effect of gender and academic self-efficacy on the

achievement of students with hearing impairment in ecology ($F_{(1,39)}$ = 0.212, P>0.05; η^2 = 0.008). Therefore, the null hypothesis 2 is not rejected.The mean scores of the participants based on gender and academic self-efficacy are presented on figure 2 below.

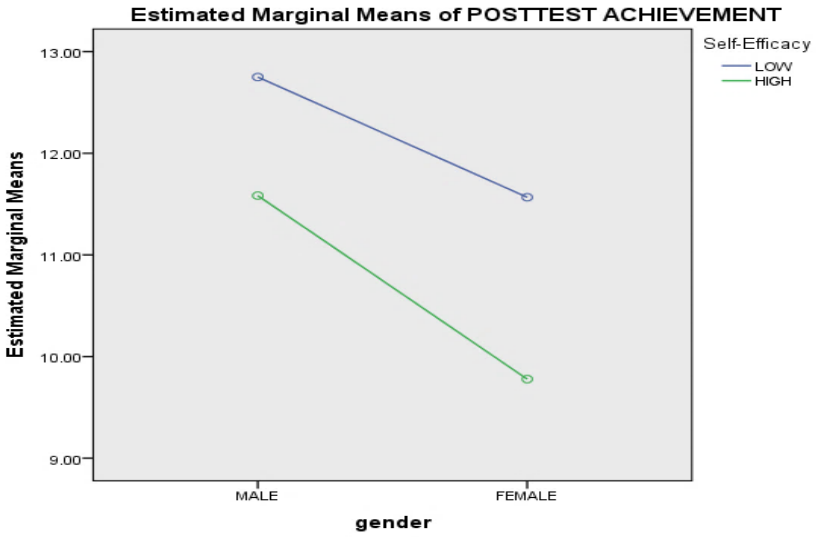

Figure 2: Mean scores of the participants based on gender and academic self-efficacy

Figure 2 above shows the mean scores of genderand academic self-efficacy. It shows that male students with hearing impairment with low academic self-efficacy had a mean score of 10.000 while their counterparts with high academic self-efficacy had a mean score of 13.214. Similarly, female students with hearing impairment with low academic self-efficacy had a mean score of 10.444 while their counterparts with high academic self-efficacy had a mean score of 9.555. This mean score however, is not statistically significant on the achievement of students with hearing impairment in ecology. However, it could predict that male students with hearing impairment would have a high achievement in ecology.

Hypothesis 3: There is no significant interaction effect of treatment, gender and academic self-efficacy on the achievement of students with hearing impairment in ecology.

The results from Table 1 above shows that there was no significant interaction effect of treatment, gender and academic self-efficacy on students with hearing impairment achievement in ecology ($F_{(1,39)}$ = 1.576, P>0.05; η^2 = 0.101). Therefore, the null hypothesis 3 is not rejected. Figure 3 below shows the graphical representation of the estimated marginal meansbased between treatment, gender and academic self-efficacy.

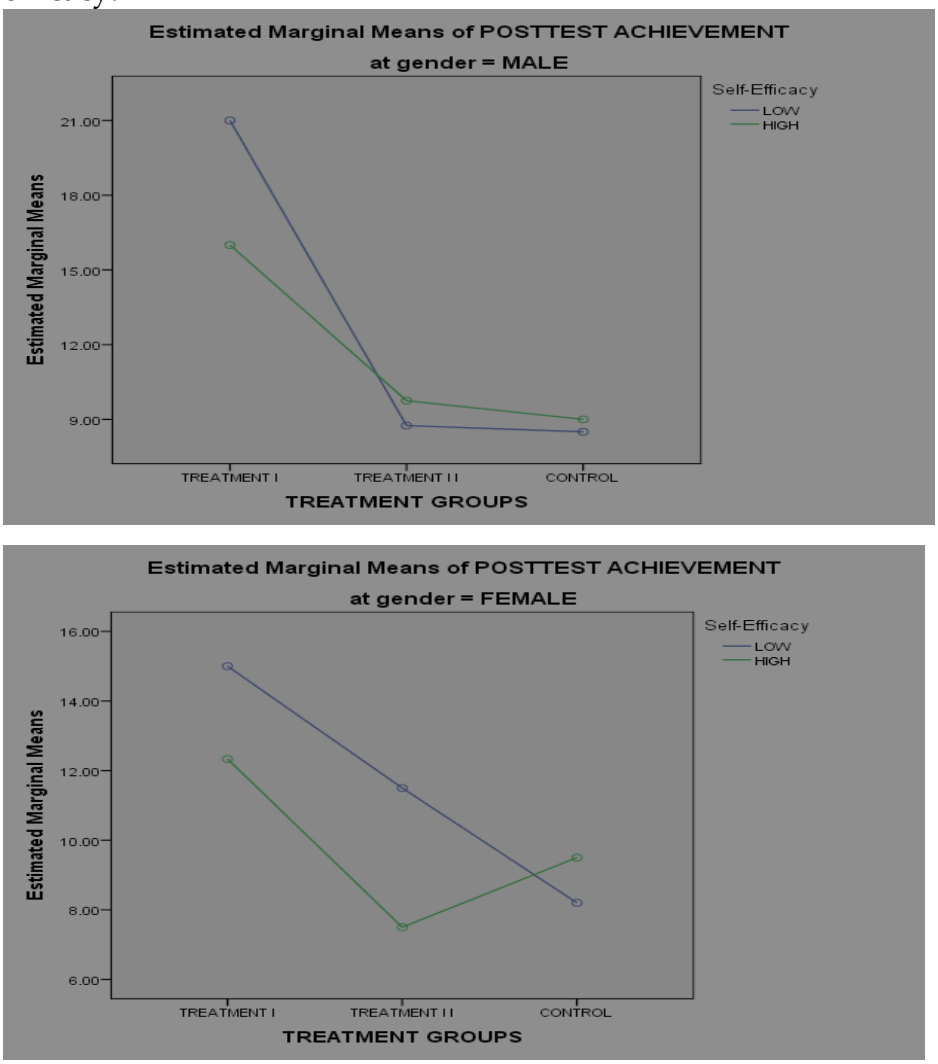

Figure 3: Graphical representation of the estimated marginal means based between treatment, gender and academic self-efficacy

Figure 3 shows the discrepancies in achievement in ecology among male and female students with hearing impairment in Ibadan, Oyo State, Nigeria. The graph reveals a downward slope (from CAI to CM and to the control group) in the achievement in ecology of male students with hearing impairment irrespective of their level of academic self-efficacy. Similarly, female students with hearing impairment who had low academic self-efficacy had a sharp downward slope from treatment group I to treatment group II and to the control group. A downwards slope was also observed between the achievement in ecology of female students with hearing impairment who had high academic self-efficacy but there was an upwards slope between the female participants who had high academic self-efficacy in the treatment group II and the control group. This observed phenomenon may be due to the zeal shown towards the learning process by thosefemale participants who had high academic self-efficacy in the control group.

Discussion of results

The findings revealed a significant main effect of treatment on the achievement of students with hearing impairment in ecology. Therefore, the null hypothesis 1 is not accepted. This implies that the treatment (both computer-assisted instruction and concept mapping) has a significant main effect on achievement in ecology by students with hearing impairment. These findings corroborate that of Moore and Calvert (2000); Christina *et al*. (2006) and Muraina *et al*. (2011) who examined the effects of computer-assisted instructional method on students' performance in different capacities and found that the use of CAI was effective for high academic performances. More importantly, their studies observed that using teaching activities that involves student's interactions with technological application in the classroom promotes meaningful learning outcome, problem solving skills, critical thinking, increase motivation and achievements. Okebukola (1990); Kinchin (2000); Akeju**,** Simpson**,** Rotimiand Kenni (2011) as well as Udeani and Okafor (2012) observed positive effect of concept maps on achievement of students in science subjects, to revise and summarize study materials. Udeani and Okafor (2012) studied the comparative effectiveness of the expository and concept mapping

instructional strategy to determine the achievement of slow learners in biology concepts and found out that those taught by the concept mapping instructional strategy performed significantly better than their expository group counterparts did. However, the current study negates the findings of Ahiatrogah *et al*. (2013) who found no significant difference between the achievement in pre-technical skills of 59 junior high school students who were exposed to CAI and conventional teaching strategies.

The result from Table 1 about hypothesis 2 found no significant interaction effect of gender and academic self-efficacy on the achievement of students with hearing impairment in ecology. Therefore, the null hypothesis 2 is not rejected. Although, mean score is not statistically significant on the achievement of students with hearing impairment in ecology, itt could predict that male students with hearing impairment would have a high achievement in ecology. This study supports Bandura (1986,1997) who stated that self-efficacy is the individuals' assessment (irrespective of gender role) of their capabilities to organize and execute actions required to achieve successful levels of performance, their aspirations, level of motivation and academic accomplishments. Compeau and Higgins (1995) showed higher preclinical self-efficacy scores by their study participants irrespective of sex roles support the use of CAI as an important aspect of clinical education. Akçay *et al*. (2006) also noted that methods that use computers in learning strengthens students' motivation, self-efficacy and educational processes.

The results from Table 1 about hypothesis 3 show no significant interaction effect of treatment, gender and academic self-efficacy on students with hearing impairment achievement in ecology. This implies that gender and academic self-efficacy are not a major determinant in whether or not students with hearing impairment should be exposed to ecology when exposed to computer-assisted instructions and concept mapping instructional strategies. In other words, when students with hearing impairment are exposed to learners-centred educational instructions (such as the computer-

assisted instruction and concept mapping) there is a tendency of enhanced academic achievement, most especially in biology and other related sciences. This finding is in line with the studyby Ige (1998), Basturk (2005), Christina *et al*. (2006), Yusuf and Afolabi (2010), Muraina, Adeleke and Rahman (2011), Sowunmi and Aladejana (2013) and Abimabade (2014) who stated that the use of computers and other innovative instructional strategies in a classroom setting cannot be over-emphasized. More so that computer usage as an educational aid has been effective in stimulating student's interest and in providing individualized tuition at the students own pace and direction. On the contrary, the findings of the current study do not conform to that of Boujaoude and Attieh (2003). Ifeako (2005) and Obeka (2007) who reported that male students have higher achievements and interest scores in chemistry than females. The duo (Ifeako, 2005 and Obeka, 2007) attributed their findings to sex-role, stereotyping, masculine image of science and female socialization process.

Conclusion

The study investigated the effect of computer-assisted instructions and concept mapping on the achievement of students with hearing impairment in ecology in Ibadan, Oyo State, Nigeria. The study revealed that both instructional strategies (CAI and CM) had positive influence on the achievement of students with hearing impairment in ecology. Therefore, students with hearing impairment can be taught effectively by using the two strategies. Between the two instructional strategies, the study revealed that the computer-assisted instruction is a more effective teaching strategy for teaching ecology. The study also concluded that gender and academic self-efficacy are not a major determinant in whether or not students with hearing impairment should be exposed to ecology when exposed to computer-assisted instructions and concept mapping instructional strategies.

Recommendation

Based on the findings of this study, it is recommended that:

- Students with hearing impairment in the biology classrooms and other science subject should be motivated to use self-learning, engaging and technologically appealing instructional strategies such as the computer-assisted instruction (CAI) and concept mapping (CM) so thattheir usage will not serve as a burden or waste of time.
- Concerted effort should be made by school administrators and the Ministry of Education to provide schools of students with hearing impairment with enough funding for the purchase of necessary materials like ICT facilities that will improve the learning outcomes in biology.
- Pre-service teachers should also be trained to gain new skills for facilitating learning in a technology-rich constructivist-learning environment.

References

Abimbade, A. (2014). Technology in and of resources in teaching and learning of mathematics: anti-dote for math-phobia. *An Inaugural Lecture, 2013/2014,* University of Ibadan, Ibadan.

Abimbola, I. O. and Abidoye, F. O. (2013).Effect of qualification and experience of biology teachers on the status of ecology teaching in Kwara State.*Journal of Education and Practice,*4(24): 1-8.

Ahiatrogah, P. D., Madjoub, M. B. and Bervell, B. (2013).Effect of computer-assisted instruction on the achievement of basic school students in pre-technical skills. *Academic Journal of Interdisciplinary Studies,*2(1): 77-86.

Aja, J. O. (2005). Environmental education as a panacea for a sustainable development in Nigeria: schools environment in focus. *African Journal of Environmental Laws and Development Studies,*1(1): 114–127.

Akçay, H., Durmaz, A., Tüysüz, C. and Feyzioglu B. (2006). Effects of computer based learning on students' attitudes and achievements towards analytical chemistry. *Turkish Online Journal of Educational Technology,*5(1): Article 6.

Akeju, O. O. S., Rotimi, C. O and Kenni, A. M. (2011).Teaching with concept mapping instructional strategy in Nigeria secondary

schools.*Proceedings of the 2011 International Conference on Teaching, Learning and Change.*637-643.

Ausubel, D. P. (1960).The use of advance organizers in the learning and retention of meaningful verbal materials.*Journal of Educational Psychology,* 51(5): 267-272.

Ausubel, D. P. (1968).*Educational psychology: A cognitive view*. New York: Holt, Rinehart and Winston.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self – efficacy: The exercise of control.* New York: Freeman.

Basturk, R. (2005). The effectiveness of computer-assisted instruction in teaching introductory statistics.*Educational Technology and Society,* 8(2): 170-178.

Bello, G. and Abimbola, I. O. (1997). Gender influence on biology students" concept-mapping ability and achievement in evolution.*Journal of Science Teaching and Learning,* 3(1&2): 8-17.

Boujaoude, S. and Attieh, M. (2003).*The effect of using concept maps as a study tool on achievement in chemistry.* Paper presented at the Annual Meeting of the National Association *for* Research in Science Teaching, Philadelphia.

Christina, W., Lars, L., Brooke, I., Eric, D. and Sven, L. (2006).Behavioural improvements associated with computer-assisted instruction for children with developmental disabilities. *The Journal of Speech-Language Pathology and Applied Behaviour Analysis,*31: 5-18.

Chularut, P. and DeBacker, T. K. (2004).The influence of concept mapping on achievement, self-regulation, and self-efficacy in students of English as a second language.*Contemporary Educational Psychology*, 29(3): 248-263.

Compeau, D. R., and Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *Mis Quarterly*, 19(2): 189–211.

Danmole, B. T. and Femi-Adeoye, K. O. (2004).Effects of concept mapping techniques on senior secondary school achievement and retention in ecology concepts.*Journal of STAN,*39(1&2): 31-37.

Ekwueme, C. O. and Umoinyang I. E. (2005). Gender difference in mathematics: Factors among secondary school students in Calabar, Cross Rivers State. *45th Annual Conference Proceedings of STAN* 224-228.

Federal Government of Nigeria.(2004). *National Policy on Education*. Lagos.

Hewson, M. G. (1986). The acquisition of scientific knowledge: Analysis and representation of student conceptions concerning density. *Science Education,*70(2): 159–170.

Ifeako, A. C. (2005). *Evaluation of commercially produced computer-assisted instruction package for teaching secondary school chemistry*.Ph.D Thesis, University of Nigeria, Nsukka.

Ige, T. A. (1998). Concept mapping and problem-solving teaching strategies as determinants of learning outcome in secondary school ecology in Nigeria.Ph.D Thesis.Department of Teacher Education, University of Ibadan. Ibadan.

Ikitde, G. A. and Edet, U. B. (2013). Influence of learning styles and teaching strategies on students' achievement in biology. *Voice of Research,*1(4): 5-13.

Isa, H. (2005). Gender in-balance in access to education: implications for production of female science teachers. *JSTAN,* 40(1&2): 45-52.

Khajavi, Y. and Ketabi.S. (2012).Influencing EFL learners' reading comprehension and self-efficacy beliefs: The effect of concept mapping strategy.*PortaLinguarum,* 17: 9-27.

Kinchin I. M. (2000).Using concept maps to reveal understanding: A two-tie analysis.*School Science Review,* 81: 41-46.

Lagoke, B.A., Jegede, O.J., and Oyebanji, P.K. (1997).Towards an elimination of the gender gulf in science concept attainment through the use of environmental analogs. *International Journal of Science Education,*19(4). 365-380.

Madorin, S. and Iwasiw, C. (1999). 'The effects of computer-assisted instruction on the self-efficacy of baccalaureate nursing students.*The Journal of Nursing Education,*38(6). 282-95.

McClure, J. R., Sonak, B., and Suen, H. K. (1999). Concept map assessment of classroom learning: reliability, validity, and

logical practicality. *Journal of Research in Science Teaching,* 36, 475-492.

Moore, M. and Calvert, S. (2000). Brief report: Vocabulary acquisition for children with autism: teacher or computer instruction. *Journal of Autism and Developmental Disorders,* 30, 359-362.

Muraina, I. O, Adeleke, I. A. and Rahman, M. A. (2011). Computer-Assisted Instruction for teaching/learning process and its effects on students' performance in tertiary institutions. *International Journal of Computer Trends and Technology,*2,15-19.

National Educational Research and Development Council (NERDC).(2009). *Senior Secondary Education Curriculum, Biology for Senior Secondary Schools 1-3*. Abuja.

Nikolaraizi, M. and Theofanous, M. (2012). The strategical use of concept maps in reading comprehension of students who are deaf. In A. J. Cañas, J. D. Novak, J. Vanhear, (Eds.). Concept Maps: Theory, Methodology, Technology. Proc. of the Fifth Int. Conference on Concept Mapping. Valletta, Malta.

Novak, J. D. (1991). Clarify with Concept Maps: A Tool for Students and Teachers Alike. *The Science Teachers,*58, 45-49.

Obeka, S. S. (2007). *Comparative effects of epodewald and power simulation games on students' achievement and interest on some environmental education concepts in goegraphy.*Ph.D Thesis, University of Nigeria.

Okebukola, P.A.O. (1990).Attaining meaningful learning of concepts in genetics and ecology: an examination of the potency of the concept-mapping technique.*Journal of Research in Science Teaching,* 27(5). 493-504.

Omofonmwan, S. I.andOsa-Edoh, G. I. (2008). The challenges of environmental problems in Nigeria. *J. Hum. Ecol.,* 23(1): 53-57.

Safayeni, F., Derbentseva, N. and Canas, A. J. (2005). A theoretical note on concepts maps need for cyclic concept maps. *Journal of Research in Science Teaching,* 33: 569-600.

Sangodoyin, I. A. (2011).Effects of computer graphics and animation presentation modes on senior secondary school learning outcomes in biology in Southwestern Nigeria.Ph.D Thesis. Ibadan. University of Ibadan.

Sowunmi, O, and Aladejana, F. (2013).Effect of simulation games and computer-assisted instruction on performance in primary science.*Proceedings of the 2013 WEI International Academic Conference.* Orlando. USA.

Udeani, U. and Okafor, P. N. (2012).The effect of concept mapping instructional strategy on the biology achievement of senior secondary school slow learners. *Journal of Emerging Trends in Educational Research and Policy Studies,* 3(2): 137-142.

WAEC, (2010).*Chief Examiner's Report.* Lagos, Nigeria: WAEC.

WAEC, (2013).*Chief Examiner's Report.* Lagos, Nigeria: WAEC.`

Yenice, N. (2006). The effect of computer-assisted science teaching on students' science and computer attitudes.*The Turkish Online Journal of Educational Technology,* 2(4): Article 12.

Yusuf, M. O. and Afolabi, A. O. (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.

Zanting, A, Verlop, N. and Vermunt, J. D. (2003).Using interviews and concept maps to access mentor teachers' practical knowledge. *Higher Education,* 46, 195-214.