Influence of Concept Map and Simulation-Game Instructional Strategies, Gender and School Location on Students' Interest in Environmental Concepts in Chemistry

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Abstract

The study investigated the comparative effects of concept mapping and simulation-game teaching strategies on students' interest in environmental concepts in chemistry. The quasi-experimental, pre-test, post-test, non-equivalent control group design was adopted. The sample used comprised of four hundred and sixty-seven (467) SS2 chemistry students randomly drawn from four (4) single-sex schools. The instrument for data collection was Environmental Concepts Inventory (ECI), while six research questions and six null hypotheses guided the study. Three intact classes were assigned to concept mapping, simulation-game and lecture method groups. Means, standard deviations were used to answer the research questions, while ANCOVA and Multiple Classification Analysis (MCA) using the Scheffe's test were used to test the null hypotheses at 0.05 level of significance. Results revealed that the simulation-game teaching strategy was most effective in enhancing students' interest than the concept-mapping strategy. Influences of gender and school location on students' interest were both not significant. Similarly, there were no significant interaction effects of teaching strategy and gender or school location or both on students' interest. Based on the findings, some recommendations were made.

Key Words: Concept Map, Simulation-Game, Gender, School Location, Students' Interest

Introduction

The emergence of modern scientific and technological activities and rapid industrialization and all geared towards economic growth, combating hunger and provision for other basic human needs has led to a drastic transformation of environmental situation. These activities have put pressure on the natural environment so much such that the rate at which they are causing environmental degradation is far outrunning the environmental self-capacity to regenerate, and this has resulted in serious environmental problems world over (Okechukwu 2002). Eguabor, (2005) identified the problem of pollution and solid waste among others as major causes of environmental degradation in Nigeria. Some of these wastes are toxic, flammable, and non-biodegradable while others are more of a nuisance than a danger to man. Solid wastes are common sights in residential zones, schools, market areas, motor parks, along the streets and numerous other locations where wastes are generated. Further compounding the problem, Osuafor (2001) reported, is the unavailability and or poor implementation of regulating bye laws on solid waste management.

The intervention measures introduced by government towards tackling environmental problems include the infusion of environmental education (EE) topics at primary, secondary and adult education levels. It has been reported that the teaching of the infused`w EE topics aimed at

addressing the environmental problems has not been vigorously and purposefully implemented and so it does appear that the infusion of EE concepts into school curriculum seem not to be achieving the desired objectives (Osuafor, 2001; Eguabor, 2005).

Chemistry as an academic discipline in Nigerian secondary schools is one of the subjects into which environmental concepts have been infused. Therefore, the syllabii of chemistry contain concepts and processes ranging from physical, organic and inorganic chemistry to infused concepts in EE. The EE concepts are examined alongside the core chemistry concepts in the same examinations such as West African School Certificate Examination (WASC) and National Examination Council (NECO) SSCE. Unfortunately, indices from these examination bodies have shown consistent trend of low enrolment and poor achievement of students in these examinations. Investigation of the cause of poor achievement, researchers (Ifeakor, 2005; Njoku, 1997; 2007; Longjohn, 2009; Ezeudu, 1995; and Okeke, 2011) reported that lack of qualified teachers, ill-equipped laboratories and inappropriate teaching strategies were some of the factors responsible for the recorded poor achievement and declining interest of students in the subject with inappropriate teaching strategies as the major cause. However, while these studies examined achievement, interest and retention in other core areas of chemistry, the EE aspects of the chemistry syllabus has not been examined for conceptual difficulties and \or poor achievement and interest by students, these infusions and teaching of environmental concepts\issues in subjects in school curricula including chemistry. Since the environmental problems that necessitated these infusions and teaching of EE concepts in chemistry as well as other subjects, continue to aggravate in alarming and complex proportions, it therefore becomes necessary to investigate into students' interest in environmental concepts in chemistry. Since NERDC came up with the infusion for the attainment of the objectives of EE such as (i) awareness (ii) knowledge (iii) attitude (iv) skill (v) evaluation ability and participation in solving present environmental problems, and preventing new ones (UNESCO-UNEP 1986), the objectives according to Osuafor (2001) are very far from being achieved judging from the fact that the attitude of the citizens towards the environment have not changed. This is not unexpected when it has been reported (Ahove and Mabo 2001; Osuafor, 2001; Eguabor, 2005) that the infused EE concepts are not being properly taught in schools. It can be deduced therefore that one major challenge facing the chemistry teachers is the exploration and adoption of teaching strategies that will be able to reverse this trend of poor achievement in both core and infused EE concepts in chemistry. Longjohn, (2009); Okeke, (2011); Ifeakor, (2005); have reported that activity oriented and problem-based teaching strategies which involve the active participation of the students are more effective in motivating and enhancing students' interest much more than the conventional lecture method currently dominating chemistry class instructions. Concept mapping, field trips, simulation game/ role play are some of the strategies described by UNESCO/UNEP (1998) as being of high potential value to the science teacher and quite essential to the teaching of science for EE.

Concept mapping as defined by Novak (1990) are diagrams indicating inter-relationship among concepts as representation of meanings or ideational framework specific to a domain of knowledge. It is a meta-cognitive tool developed initiating as a research tool to represent learners' prior, relevant knowledge and later as a tool to enhance meaningful learning. The development of the strategy was based on Ausubel's assimilation theory which is based on the principle that the single most important factor influencing learning is what the learner already knows (prior knowledge). The fundamental idea in Ausubel's cognitive theory is that learning takes place by assimilation of new concepts and prepositions into existing concepts and prepositional structures

or framework held by the learner. The knowledge structure already held by the learner is also referred to as the individual's cognitive structure.

While constructing concept maps, concepts are usually enclosed in circles or boxes and the relationship between or among concepts are indicated using cross-links or connecting lines that link them together. The relationship between or among concepts are articulated in linking phrases or words on the connecting lines eg "gives rise to", "results in", "is required by", "contribute to" or "causes" . Furthermore, concepts are arranged and presented in a hierarchical order, with the most inclusive, most general concepts at the top of the map and the less general, more specific concepts arranged below. Novak and Gowin (1984) opined that the number of hierarchical levels address the degree of subsumption, the number of branching indicate progressive differentiation and the number of cross links indicates the degree of integration of knowledge. Concept maps can be constructed from texts, during and/or after class discussion/lecture. Concept maps can be used to assess the learners' prior knowledge, externalize and make explicit the conceptual knowledge (both correct and erroneous) that students hold in a knowledge domain. Students while constructing concept maps adopt an active, deep questioning approach to the subject matter and such active, self engaging transformational interaction with learning material enhances learning in general.

Simulation as defined by encyclopedia of Education is an operating model reproduction or imitation of physical or social phenomena consisting of a set of interrelated factors or variables which function in essentially the same manner as the actual or hypothetical system. It is a concentration of imitation learning experience specifically designed to represent real-life activities by providing the learner with the essential elements to model real-life activity. A simulation is a form of experimental learning and may take a number of forms; they may contain elements of game, a role play or activity that acts as a metaphor. The goal of simulations is not to win but to acquire knowledge Instructional Games as defined by Abe (2003) are structured activities with set rules for play in which two or more participants interact to reach clearly designed instructional objectives. while a game is a form of enjoyable and competitive play or spot, bound by rules to achieve specified goals (winning, victory, pay off) that depend on skill and often involve chance, simulation on the other hand is a role-playing which involve people adopting roles in a mock-up of a situation-there need not to be a winner rather a changed condition or situation to be achieved by participants (Akinsola & Animashun, 2007). Both game and simulation share some common features such as in the use of tactics and strategies from the participants' initiative, their ability to provide drill and practical applications where students learn in a play-way which removes aversion, the active participation of students in assuming roles with learning generated by social dialogue and or in decision making towards solving a problem. The boundary between game and simulation is so superficial that often times the two approaches are used interchangeably, while some writers prefer to combine the two terms 'simulation-game' to represent instructional games generally. This approach was adopted in this study in which simulation-game would be regarded as a structured imitation of reality which makes use of role play and game elements to stimulate real situations for problem solving. The opportunity for debriefing is one of the strengths of simulation-game exercise. During debriefing, important issues in the exercise are highlighted and discussed; co-operation and conflicts resulting from the exercise are equally harmonized. Researchers (Obeka, 2007; Akinsola & Animashun, 2007) reported that the simulation-game strategy may be effective for teaching complex and real world situations which changes as the students are involved in the activity. On the other hand, Canas (2003) reported that in the course of constructing concept maps, learners adopt an active, deep and questioning approach to the

subject matter, and that such active self-engaging transformational interaction with learning material may enhance learning in general. From these reports, it may be that concept mapping and or simulation-game teaching strategy or both will effectively enhance students' interest in environmental concepts in chemistry. Therefore, this study investigated the comparative efficacies of this two activity oriented teaching strategies in enhancing students' interest. All the studies renewed compared each of these strategies separately with the conventional lecture method. In addition to teaching strategies adopted, interest of students may also be influenced by gender.

Gender is a socially ascribed attribute which differentiates feminine from masculine (Imoko, 2005). Gender is used to describe certain characteristics of men and women which are culturally and socially determined while those that are biologically determined are regarded as sex. Gender has been reported (Nwagbo & Chukelu, 2011; Imoko, 2005; Okeke, 2011; Njoku, 1997) as one of the factors interacting with the interest of students. However, there is inconsistency as to the nature, extent and source of the recorded differences in the interest of male and female students. For instance, while Opara (2002) and Imoko (2005) reported no significant influence of gender on students' interest, Isa (2005) reported a significant influence of gender and in the favour of males. Similarly, school location has been implicated (Osuafor, 2001; Njoku, 1997) as another factor that affects students interest in chemistry and the results are equally conflicting. While Osuafor (2001) reported results in favour of students in rural location, Njoku (1997) and Imoko (2005) reported in favour of students in the urban location. Eguabor (2005) noted that in traditional societies, earlier times culture of our fore-parents ensured environmental protection and allowed neither indiscriminate waste dumping nor destruction of natural resources. Will the students from schools in the rural locations show more interest than their urban counterparts in the environmental concepts in chemistry? This study answered the question. Due to the conflicting reports on the influence of gender and school location, on students' interest, this study is expected to contribute to the debate by investing the comparative effects of concept mapping and simulation-game teaching strategies, gender and school location on students' interest in environmental concepts in chemistry.

Purpose of the study

The purpose of the study was to determine the comparative effect of concept mapping and simulation-game strategy, gender and school location on the interest of students in environmental concepts in chemistry. Specifically, the study

1. determined whether there is any significant difference in the interest mean scores of students in ECII due to teaching strategy.

2. determined whether there is any significant difference in the interest mean scores of male and female students in ECII after treatment.

3. determined whether there is any significant difference in the interest mean scores of students in rural and urban locations taught the same concepts using the same teaching strategy.

4. determined the interaction effect of teaching strategy and gender on students' interest in the environmental concepts in chemistry.

5. determined the interaction effect of teaching strategy and school location on students' interest.

6. determined the interaction effect of teaching strategy, gender and school location on students' interest.

Research Questions

The study was guided by the following research questions

1. What is the effect of teaching strategy on students' interest?
2. What is the influence of gender on students' interest in environmental concepts?
3. What is the influence of school location on students' interest?
4. What is the interaction effect of teaching strategy and gender on students' interest?
5. What is the interaction effect of teaching strategy and school location on students' interest?
6. What is the interaction effect of teaching strategy, gender and school location on students' interest?

Hypotheses

The study was guided by the following null hypotheses tested at $p<0.05$.

1. There is no significant difference in the interest mean scores of students due to teaching strategy.

2. There is no significant difference in the interest mean scores of male and female students.

3. There is no significant difference in the interest mean scores of students in rural and urban locations

4. There is no significant interaction effect of teaching strategy and gender on students' interest.

5. There is no significant interaction effect of teaching strategy and school location on students' interest.

6. There is no significant interaction effect of teaching strategy, gender and school location on students' interest.

Method

The study employed the quasi-experimental, pre-test, post-test, non-randomized control group design.

The population consisted of all senior secondary class two (SS2) students who offer chemistry in all the forty-four government owned secondary schools in Nnewi Education Zone (NEZ) of Anambra state. The sample comprised four hundred and Sixty-seven (467) SS2 chemistry students drawn through purposive and multi-stage stratified random sampling technique from four (4) single-sex; 2 male schools and 2 female schools ensuring the 2 schools (1 male, 1 female) were drawn from schools in the rural location, while the other 2 (1male , 1 female) were drawn from urban location. Single sex schools were used to avoid interferences between boys and girls as gender was a variable in the study. Similarly, schools were drawn from both rural and urban locations because school location was also a variable in the study. Therefore, both purposive and stratified random sampling techniques were employed in drawing the sample. It was purposive because the researcher wanted to use only schools that had three or more arms of SS2 chemistry

students and stratified to balance the representativeness of the sample considering gender and school location.

Environmental Concepts Interest Inventory (ECI) was the instrument used for the study. The ECII is a 28-item, 4-point Likert type response scale developed by the researcher based on the following environmental concepts in chemistry namely-pollution (a) Air pollution, ozone/ozone layer depletion, green house effect, acid rain (b) water pollution (c) land pollution-solid waste management (disposal). The research instrument was face-validated by two experts in the Department of Science Education. The construct validity of the ECII was determined using Factor-Analysis. The Factor Analysis which adopted Principal Component Analysis method yielded eight factors. The 28 items of the ECII loaded above .35 in only one factor and were therefore factorially pure. Furthermore, its reliability coefficient was 0.94 obtained using Crombach-alpha. Three teaching strategies employed in the study were; concept mapping (E_1), simulation-game (E_2) as experimental groups and the lecture] method (C) as control.

Experimental Procedure

The actual teaching was done by the regular chemistry teachers in the selected schools. They were trained for four days during which they were adequately exposed to the concepts and strategies involved in the study. A pre-test was administered to three intact classes after they had been randomly assigned to groups, (E_1, E_2 and C) in each of the sampled schools a day before the commencement of the experiment. In concept mapping-group E_1, the teacher began the lesson with a brief explanation of what concept mapping is and how it is constructed using concept maps constructed by the researcher. Thereafter, the students were instructed to construct their own concept maps as the lesson proceeds and also after the lesson under the teacher's supervision.

In group E_2-simulation-game, the students were taught conventionally prior to the game exercise. Pre-game hand-outs/role cards were given to the students in advance to get prepared for their roles and procure the necessary materials needed for the game. In the treatment, the students were divided into groups according to their roles and after a brief introductory lesson, the simulation-game exercise took off. There was a debriefing session at the end of the game. It was a general discussion highlighting important points in the exercise. During this time, the experiences of the participants were sought, the views of the teacher were passed on to the participants and effects of co-operation and conflicts resulting from the learning experience were harmonized. In the control group C, the lecture method only was used.

The teaching lasted for five weeks. Post-test were administered to all the groups in each school a day after the completion of treatment. The pre-test and post-test scores were analyzed using mean and standard deviation scores to answer the research questions while ANCOVA, and Multiple Classification Analysis (MCA) using Scheffe's test were used for testing the hypotheses at 0.05 level of significance.

Presentation of results

Results are presented according to research questions and the hypotheses.

Research question 1 sought information on the comparative effects of teaching strategies (concept mapping and simulation-game) on the interest mean scores of students in ECII. Data for answering research question 1 is presented in table 1.

Table 1: Mean Effects of Three Teaching Strategies on Students' Interest in Chemistry

Treatment Group	N	Pre-test $\bar{X}$	SD	Post-test Mean $\bar{X}$	SD	Mean gain
Concept mapping (E_1)	157	1.67	0.72	3.19	.44	1.52
Simulation-game (E_2)	154	1.71	0.71	3.37	.52	1.66
Lecture method (C)	156	1.71	0.72	1.90	.44	0.19

Data on the table above shows that the Simulation-Game Teaching Strategy (SGTS) had the highest mean gain of 1.66 followed by concept mapping (CMTS) with 1.52 and then control group (CLM) with 0.19. This implies that E_2-simulation-game strategy appears to have the greatest influence on students' interest than concept mapping strategy. Both concept mapping and simulation-game recorded higher interest mean gains than the lecture method. In order to make a decision on students' interest based on the different teaching strategies, hypotheses 1 which stated that there is no significant difference in the interest mean scores of students in ECII due to teaching strategy was tested at 0.05 level of probability as presented in Table 2

Table 2: Summary of Analysis of Covariance Results.

Source	**Sum of Squares**	d*f*	**Mean squares**	*f*	**Sig.**	**Decision**
Corrected model	209.2269	12	17.435	84.230	.000	
Intercept	503.225	1	503.223	2.431E3	.000	
Pre ECII	.950	1	.950	4.588	.003	
Methods	201.9422	2	100.971	487.789	.000	S
Locations	.662	1	.662	3.199	.074	Ns
Gender	.002	1	.442	2.935	.107	Ns
Interactions						
Location and Gender	1.53	1	.453	2.572	.119	Ns
Method and location	.797	2	.898	2.340	.114	Ns
Method and gender	.328	2	.464	2.623	.104	Ns
Method and location and gender	.830	2	.415	2.005	.136	Ns
Error	93 .977	454	.207			
Total	4011.110	466				
Corrected total	303.202					

Data on table 2 shows that teaching strategy as main effect is significant on students' interest. This is shown by the calculated f-value of 487.789 which is significant at .000 level. To determine the direction of the observed significant differences, a multiple comparison analysis was conducted using Scheffe's test and the result is presented in Table.

Table 3: Results of Multiple Comparison Analysis of Students' Interest Scores x Teaching Strategies Using Scheffe's Test

(i)Teaching Strategy	(j)Teaching Strategy	Mean Differences (i-j)	Std Error	sig level	Decision
Concept mapping	Simulation-game	-18354*	.05322	.003	S
	Lecture method	1.2910	.05305	.000	S
	Concept mapping	-18354*	.05322	.003	S
Simulation-game	Lecture method	1.47464	.05330	.000	S
	Concept mapping	-1.29110*	.05305	.000	S
Lecture method	Simulation-game	-1.47464*	.05330	.000	S

Results of the Scheffe's post-hoc pair wise test show that significant difference existed between concept mapping and simulation-game. Significant difference also exist between groups (E_1 & E_2) and the control group C. therefore the simulation-game strategy is significantly more efficient than the concept mapping in promoting students' interest in chemistry while both strategies are significantly superior to lecture method in enhancing students' interest.

Research question 2 sought information on the influence of gender on students' interest in environmental concepts in chemistry. Data used for answering this question is presented in Table 4.

Table 4: Mean and Standard Deviation Scores of Students' Interest by Gender

		Pre-test		Post-test		Mean
Gender	N	$\bar{X}$	SD	$\bar{X}$	SD	gain
Males	232	1.71	.72	2.77	.73	1.06
Females	235	1.67	.72	2.86	.87	1.19
Total	467	1.69	.72	2.82	.81	1.13

Table 4 shows that females showed more interest with interest mean gain of 1.19 than the males with a lower interest mean gain of 1.06. To determine if this observed difference is significant, hypotheses 2 was tested at $p<0.05$. Table 2 reveals that there is no significant difference in the interest of male and female students. This is shown by the calculated f-value of 2.935 which is not significant at 0.107. To this effect, the researcher failed to reject the null hypotheses and concluded that there was no significant difference in the interest mean scores of male and female students.

Research question 3 sought information on the effect of school location on students' interest in environmental concepts in chemistry. Data on table 5 was used to answer this question.

Table 5: Mean and Standard Deviation scores of Students' Interest Scores x School Location

School Mean Location gain	N	Pre-test $\bar{X}$	SD	Post-test $\bar{X}$	SD
Urban	235	1.7	.74	2.79	.73	1.09
Rural	232	1.68	.69	2.85	.88	1.17
Total	467	1.69	.72	2.82	.81	1.13

Students from rural location appear to have shown more interest since they had a higher interest mean gain of 1.17 than their urban counterparts with 1.09. On testing hypothesis3, table 2

revealed that this difference is not significant as shown by the calculated f-value of 3.199 which is not significant at 0.074. The decision therefore was to fail to reject the null hypothesis and conclude that there is no significant difference in the interest of students in environmental concepts in chemistry due to school location. Research question 4 sought information on the interaction effect of teaching strategy and gender on students' interest. Data on table 6 addressed the issue.

Table 6: Mean and Standard Deviation scores of Students' Interest Scores x Teaching Strategy x Gender

Teaching Strategy	Gender	Post-test N	$\bar{X}$	SD
Concept mapping (E_1)	Male	78	3.19	0.39
	Female	79	3.18	0.51
Simulation-game (E_2)	Male	76	3.28	0.41
	Female	78	3.51	0.58
Lecture method (C)	Male	78	1.19	0.43
	Female	78	1.89	0.46

Table 6 reveals that the effects of the teaching strategies on student's interest are consistent for both male and female respondents. Simulation game appears to be most efficient in promoting the interest of both males and females alike with interest mean scores of 3.23 and 3.51 for males and females respectively. It is followed by concepts mapping with 3.19 for males and 3.18 for females respectively. On testing hypothesis 4, to determine if these differences were significant, table 2 shows that the calculated f-value of 2.623 is not significant at .104 levels since it is greater than 0.05 levels. Consequently the null hypothetic was not rejected. In conclusion teaching strategy and gender have no significant interaction effect on student's interest in environmental concepts in chemistry.

Research question 5 sought information on the interaction effects of teaching strategy, and school location on students' interest. Data on table 7 provided answer to this question.

Table 7: Mean and Standard Deviation scores of Students' Interest Scores x Teaching Strategies x school Locations.

Teaching Strategy	School Location	Post-test N	$\bar{X}$	SD
Concept mapping (E_1)	Urban	79	3.12	.45
	Rural	78	3.26	.43
Simulation-game (E_2)	Urban	78	3.29	.53
	Rural	76	3.46	.50
Lecture method (C)	Urban	78	1.95	.22
	Rural	78	1.85	.58

The above table shows the interest mean scores for urban respondents are 3.12 for E_1, 3.29 for E_2 and 1.95 for control group C, while for the rural respondents, the interest mean scores are 3.26 for E_1, 3.46 for E_2 and 1.85 for C. This implies that the effects of teaching strategies on students' interest are consistent in both urban and rural locations. The table clearly shows that the

Simulation-game Teaching Strategy (SGTS-E_2) proved to be most efficient, followed by Concept Mapping Teaching Strategy (CMTS-E_1) and then the Conventional Lecture Method (CLM-C) in both urban and rural locations. In order to make a decision on these observations, hypotheses 5 that stated that there is no significant interaction effect of teaching strategy and school location on students' interest was tested at $p<0.05$. Table 2 shows that the calculated f-value of 2.340 is not significant at .114, therefore, the null hypotheses of no significant interaction effect was not rejected. Furthermore, table 2 equally revealed a no significant 3-way interaction effect of teaching strategy, gender and school location on students' interest. This is implied from the calculated f-value of 2.005 which is not significant at .136 levels. Therefore, the researcher failed to reject hypothesis 6 that stated there is no significant 3-way interaction effect of teaching strategy, gender and school location on students' interest in environmental concepts in chemistry.

Summary of Findings

1. Students in the simulation-game teaching strategy (SGTS-E_2) had a statistically significant higher interest mean scores than those in concept mapping (CMTS-E_1) and both treatment strategies were significantly more efficient than the lecture method-control group in enhancing interest of students in environmental concepts in chemistry.
2. The difference in the interest mean scores of male and female students was not significant.
3. The effect of school location on the interest of students was equally not significant.
4. There were no significant interactions of teaching strategy and gender or school location or both on students' interest in environmental concepts in chemistry.

Discussion of Findings

Result in table 1and 2 show significant main effect of treatment on interest measure. The results indicate that students' interest was greatly improved when they were exposed to the concept mapping and simulation-game teaching strategies when compared with the conventional lecture method. This is consistent with the reports of Ifeakor (2005); Osuafor (2001) and Longjohn (2009) that students' interest could be enhanced through instructional strategies. However, results of Scheffe's post-hoc pair wise multiple comparison analysis on the interest mean scores of the three groups as presented in table 3 revealed that comparatively, the simulation-game strategy is significantly more efficient than the concept mapping strategy in enhancing students' interest. This could be attributed to the fact that, in simulation-game environment, the situation feels and leads to a more engaging interaction by learner, provides motivating activities which students find enjoyable and consequently learn in a fun-filled play-way which removes aversion, tension and boredom. The superiority of simulation-game in enhancing interest as reported in this study is consistent with Obeka (2007); Akinsola and Animashun (2007); Longjohn (2009); and Onwukwe (2010) who reported that simulation-game teaching strategy motivates students' interest.

However, both concept mapping and simulation-game create room for tangible thinking because in playing games, and constructing concept maps, thoughts are connected out physically and results are seen. Another possible reason for the superior achievement recorded by the treatment groups in this study is the activity and problem oriented nature of the two strategies. In both strategies, students' attentions were focused on the learning materials as the onus of deciding what to do at each stage of the learning process falls on them.

The results of this study also indicate that gender is not a significant factor in students' interest. This is consistent with the findings of Imoko (2005), who reported that gender has no significant effect on students' interest but at variance with the views of Isa (2005) that reported

significant influence of gender on students' interest. In this study, the relative effects of concept mapping and simulation games across the students' gender are consistent, they are not sex stereotyped. Therefore a gender balanced atmosphere accounted for the superiority of the two experimental strategies in enhancing interest over the lecture method.

Similarly, table 5 shows that the students from rural location had a higher interest mean gain of 1.17 than those in the urban locations with 1.09. However, table 2 revealed that this difference is not statistically significant. This result is consistent with that of Osuafor (2001), but at variance with that of Imoko (2005) who reported a significant difference in the interest mean scores of students due to school location and in favour of those in the urban location.

Furthermore, the ANCOVA result in Table 2 shows that interaction effects between (i) teaching strategy and gender, (ii) teaching strategy and school location, (iii) teaching strategy, gender and school location were not significant implying that neither gender nor school location nor both combined with teaching strategy to affect the students' interest. On one hand, this finding gives credence to Nworgu (2004); Imoko (2005); and Nwagbo & Chukelu (2011); who reported no interaction effect between instructional strategy and gender on students' interest but on the other hand, it is at variance with Obeka (2007) report that significant interaction effect existed between teaching strategy and gender.

Recommendations

1. Science teachers should endeavour to introduce fun and interactive activities that are student-centered in their lessons in order to arouse and motivates students to learn meaningfully to enhance and sustain their interest.
2. Ministries of education at both federal and state levels in conjunction with professional associations should organize in-service training in the form of seminars and workshops on a regular basis to keep chemistry teachers abreast of the application of innovative, problem-solving and activity based teaching strategies like concept mapping and simulation.
3. Examination bodies like the West African Examination Council (WAEC), National Examinations Council (NECO) should give the environmental concepts infused in all subjects in the school curricula the importance and prominence they deserve by increasing the number of test items on these environmental concepts.

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