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EFFECTS OF CONCEPT MAPPING AND SIMULATION STRATEGIES ON BIOLOGY STUDENTS' ACADEMIC PERFORMANCE IN NERVOUS COORDINATION

Eyibio, Isangobong Akpan
University of Uyo, Uyo
isangobongeyibio@yahoo.com
08038680244

James, Godwin Donatus
University of Uyo, Uyo
godwinjames.pgs.phd@uniuyo.edu.ng
07038093643

ABSTRACT

This study was carried out to investigate the effects of concept mapping and simulation strategies on biology students' academic performance on the concept of nervous coordination. Three research questions and three null hypotheses were generated to help guide the study and these hypotheses were tested at .05 level of significance. Quasi-experimental research design using non-randomized pretest-posttest was adopted for the study. The study was conducted in two co-educational secondary schools in Ibiono Ibom Local Government Area of Akwa Ibom State. Purposive sampling technique was used to select the two schools for the study. 107 senior secondary three (SS III) Biology students made up the sample for the study. A researcher developed instrument, Biology Performance Test (BPT) with a reliability coefficient of 0.83 was used in collecting data. Data collected were analysed using descriptive statistics and Analysis of Covariance (ANCOVA). From the results, it was found that significant difference existed between the academic performances of biology students taught nervous coordination using simulation strategy and those taught using concept mapping strategy. The results also indicated that gender significantly influenced the academic performance of students taught nervous coordination using concept mapping. Based on the findings, the following recommendation were made; biology teachers should adopt simulation strategy in teaching nervous coordination in order to enhance students' academic performance in biology in secondary schools.

Keywords: Concept Mapping, Simulation, Nervous Coordination, Academic Performance, Gender

Background of Study

Biology can be describes as the study of living organisms and their inter-relationship with their immediate Surroundings. It cuts across all spheres of human engagement and plays a vital role. It is very important in the fields of agriculture, medicine, distillery and petrochemical industries and even in earth sciences and mining industries. Due to the importance of biology, emphasis has been placed on the teaching of biology specifically at the secondary school level. This is to ensure full actualization of the objectives of biology education as stipulated within the National Policy on Education, Federal Ministry of Education (F.M.E. 2013).

The objectives of the biology programme for secondary school were extracted from the National Policy on Education (2013) and therefore the cardinal objectives of the programme are to prepare students of biology to acquire:

i. Adequate laboratory and field skills in biology;
ii. Meaningful and relevant knowledge in biology;
iii. Ability to apply scientific knowledge to everyday life activities in matters of personal and community health and agriculture;
iv. Reasonable and functional scientific attitudes

In accordance with the objectives stated above, the biology programme for secondary schools is equip with contents that will help produce 21st century teachers and meet the needs of the society by putting forward relevant and functional methods, application content and processes. The National Policy on Education noted that biology education ought to guarantee adequate laboratory and field skills, significant and relevant knowledge to everyday life in matters of community and personal health and Agriculture, while maintaining functional and reasonable scientific attitude. To adequately ensure the full actualization of these fascinating objectives, the contexts and contents of the programme place great emphasis on field studies, laboratory techniques, guided discovery and skills as well as conceptual thinking.

Unfortunately, accessible statistics from West Africa Examination Council shows that students still perform poorly in biology in May/June examination. For Example, in 2013 the overall enrolment was 1300418, the percentage of students who pass at credit level and beyond in biology was 49.65% whereas 50.35% failed. In 2014, the overall enrolment was 1505199, the percentage of students who pass at credit level and beyond was 38.50% whereas 61.50% failed. This shows inconsistency among the performance of biology students.

The issue of students' performance is seen to be gender connected. 'Gender is a term used to emphasize that sex inequality is not caused by the physiological and anatomic variations

that characterize women and men, rather by the inequitable and unequal treatment socially assigned to them' (Igwe, 2003 cited in Anigbo and Ebuoh 2017). Moreso, gender alludes to the social, economic, cultural, and political conditions that make up the basis of certain standards, behavioural patterns and values related to gender and their relationship. Kinyanjui (2014) asserts that gender may be a socially and parallel unequal division into masculinity and femininity. Gender is one amongst the foremost fascinating and actively debated variables in academic analysis, however with conflicting results. Some studies (Scantlebury and Baker 2007) among others, has affirmed a significant connection between students performance and gender in biology, particularly in favour of male. It also reported that male students have higher level of academic performance in science, technology and arithmetic than their female counterparts (Akinsola and Odeyimi 2014). Other separate studies has postulated that males are superior in science, aptitudes, numerical, reasoning and spatial relationship while their female counterparts are superior in perceptual, verbal fluency, memory, speed, and manual dexterity. However, it was also reported on these studies that gender did not have any significant effect on variation in achievement scores of males and females (Badiru, 2007; Okigho and Osuafor, 2008).

The stimulated debates and arguments at the Science Teachers Association of Nigeria (STAN) workshops, conferences and seminars have given rise to the introduction of the new science modules which are currently operational at the national workshop levels and during the annual conferences. The target was to collocate methods and contents for improving the present state of achievement in biology and other sciences. The major concern is how science teachers upgrade from the traditional approach of science teaching to a new and more effective approach. Although current issues have revolved around student's performance in Science, it is also worthy to note that student's performance in any course administered to them is a function of the instruction given to them, hence this has made the methods in administering these instructions to be a factor worth considering when teaching science, various methods have been put forward to aid the effective teaching of science these methods includes but not limited to demonstration, concept mapping, virtual teaching and also simulation.

Simulation is formed as an illustration of the characteristics or behaviour of a system through the employment of another outlet specifically a computer aided programme designed for the purpose (Nwafor and Abonyi 2016). They also assert that it can mean copying, making working representations or replicas of machines for analysis or demonstration of issues however clearly portrays real life or theoretical situations. Simulation permits the learners to manipulate parameters or variables and then to view the outcome of their respective choices

(Mitchell *et al.* 2007 as cited in Umoke and Nwafor 2014). Simulation models are models that exist or already exist in a set of physical or complex social interactions or manageable representation of real events in which learners are active in the learning process by bringing their previous knowledge and skill to bear.

Simulation transforms real world events and happenings into classroom experiences, these events are usually too dangerous, difficult, fast or too slow to be capture in real life experiences, this is to help students get a first-hand experience about these events (Umoke and Nwafor 2014). Examples of some events that can be simulated for students for better understanding include; the human circulatory system showing its capillaries, veins and major arteries, earthquake, Tsunami, predator and prey occurrence which might be too fast to observe in a real-life situation and it makes learning more meaningful and concrete. It can also be used in physical science and medicine, though its importance in biology instruction is still being speculated. Simulation has being in existence for a long period of time, it dates back to 1900 when the united state military used it for training and retraining purposes, they identified major types of simulation which include constructive, live and virtual simulations which serve different purposes. These simulations are based on real life experiences and hence no one is exposed to actual dangers. The use of simulation in the teaching of biology is an area being researched on by different scholars and how instructional simulation may have fascinating effects for male and female biology students

Concept mapping is an instructional strategy first used in Cornell University by Noval and his colleagues, it is a teaching technique whereby learners are assisted to organize or arrange information about a concept in a logical manner that makes learning meaningful. Emmanuel (2013) asserts that concept mapping strategy is based on the principle that concepts do not exist in isolation, rather these concepts are related to one another in order to make meaning. The arrangement of new concepts or learning task in such a way that they are related enables the learner to make better mental connections between ideas, concepts or learning task. Ausubel's theory of assimilation for cognitive learning is the bedrock for the concept mapping strategy; the theory asserts that new concepts are acquired through assimilation into the existing concept propositional framework. Ausubel (1968) postulates that the most important factor influencing learning is the previous knowledge domicile in the learner's cognitive structure, it needs to be identified before learning can effectively take place.

Concept mapping and Simulation are activity oriented strategies used for teaching, while concept mapping has to do with information arranged in either hierarchical or diagrammatical

representation showing the inter-relationship among concepts while simulation is an instructional and experiential learning strategy where scenarios of reality are displayed for student to interact with and gather knowledge. Both concept mapping and simulation may facilitate the interconnectedness of different organs of the human body, these strategies are used with intension to motivate and encourage students to actively participate in the learning process to improve poor performance of students in nervous coordination. While it has not been substantiated that the current poor performance of students in biology examination is as a result of the non application of concept mapping and simulation strategies in administering biology instruction, the extent to which the adoption of the concept mapping and simulation strategies could enhance students' performance in biology is still an issue that need to be subjected to empirical investigations. These observations calls for investigation to explore the effectiveness of concept mapping and simulation instructional strategies on students' performance in nervous coordination in biology.

Statement of the Problem

Student's poor performance in biology in external examination has been of major concern to all stakeholders in the education sector. This has been attributed to several factors among which method of teaching contribute immensely to the performance of biology students. Teacher centered learning strategy alone does not bring about high academic performance in students due to lack of students involvement and contribution to the instruction. Hence, studies on the use of alternative strategies for teaching become necessary as a means of improving students' academic performance in science education in general and biology in particular. Based on this, the researcher decided, to investigate the effects of concept mapping and simulation strategies on biology students' academic performance in nervous coordination in biology.

Purpose of the Study

The purpose of this research is to investigate the effect of concept mapping and simulation strategies on biology students' academic performance in nervous coordination in secondary schools in Ibiono Ibom Local Government Area. Specifically, the study will:

1. Compare the performance of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy.
2. Compare the performance of male and female biology students taught nervous coordination using simulation strategy.

3. Compare the interaction effect of strategies (concept mapping and simulation) and gender on students' performance score in nervous coordination.

Research Questions

The following research questions provide focus to this study:

1. What is the difference between mean performance score of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy?
2. What is the difference between mean performance score of male and female students taught nervous coordination using simulation strategy?
3. What is the interaction effect of teaching strategies (concept mapping and simulation) and gender on students mean performance score in nervous coordination?

Research Hypotheses

Based on the research question, null hypotheses were formulated to guide to study:

1. There is no significant difference between the mean performance score of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy.
2. There is no significant difference between the mean performance score of male and female biology students taught nervous coordination using simulation strategy.
3. There is no significant interaction effect of teaching strategies (concept mapping and simulation) and gender on students mean performance in nervous coordination.

Methodology

Design of the Study

The design for the study was quasi experimental. Precisely, the pretest posttest nonrandomized control group design. The design was used because students were used their intact classes

Area of the Study

The area for this study was Ibiono Ibom Local Government Area of Akwa Ibom State. It is bounded by Itu local government to the East, Ikono to the West, Ini and Arochukwu Local

government to the North and Uyo to the South. There are 11 public secondary schools in the area.

Population of the Study

The population of the study consisted of senior secondary year three (SS3) biology students in all government owned public secondary schools in Ibiono Ibom Local Government Area (LGA). There were 857 senior secondary three (SS3) biology students comprising of 382 males and 475 females in Ibiono Ibom Local Government Area for 2018/2019 session, (Local Education Committee, Ibiono Ibom Local Government Area 2019).

Sample and Sampling Technique

The sample comprised of 107 SS3 students from two coeducational secondary schools in Ibiono Ibom Local Government area of Akwa Ibom State. Purposive sampling technique was used in selecting two schools out of the 11 schools in Ibiono Ibom LGA. Furthermore, one intact class was randomly drawn from each of the two public secondary schools used for the study; one intact class represented the Experimental group while the other is the control group.

Instrument for Data Collection

The instrument for data collection was Biology Performance Test (BPT) on nervous coordination. The BPT is a researcher-made instrument which consist of 30 multiple choice items with four (4) options A, B, C and D of which only one is the correct answer. The items were drawn from the concepts of nervous coordination.

The biology performance test (BPT) on nervous coordination was face and content validated by three experienced biology teachers, three experts and specialist in test, measurement and evaluation department, University of Uyo. A trial test was conducted using a group of thirty (30) SS3 student of the same population who were not part of the sample for the study. A reliability co-efficient of 0.83 was obtained.

Experimental Procedure

The researcher administered a pretest on Biology Performance Test (BPT) for the two groups selected for the study. Immediately after the pretest, the experimental group I and experimental group II were taught the concept of nervous coordinationby the research assistants with the supervision of the researchers. Students in the experimental group I were taught using concept mapping strategy while the experimental group II was taught using simulation strategy. The

lesson lasted for two weeks in both experimental group I and experimental group II, in both schools. At the end of the lesson, a post-test on BPT was administered to both experimental group I and experimental group II by the researcher with the help of the research assistants in an examination condition. Thereafter, the scripts were collected from the students in both groups for scoring, collation of scores and data analysis.

Method of Data Analysis

Research questions and hypotheses were answered using mean, standard deviation and Analysis of Covariance (ANCOVA). The hypotheses were tested at 0.05 level of significances.

Results

The results are presented in tables based on the research questions and hypotheses.

Research Question One

What is the difference between mean performance score of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy?

Table 1: Mean and standard deviation of students' pretest and posttest scores taught using concept mapping strategy and simulation strategy.

Strategy	N	Pretest		Posttest		Mean Gain
		$\overline{X}$	SD	$\overline{X}$	SD	
Concept Mapping	52	13.63	3.56	21.67	4.23	8.04
Simulation	55	16.55	2.82	25.31	2.76	8.76

As shown in Table 1, the mean performance scores of students' pretest and posttest scores taught nervous coordination using concept mapping is 13.63 and 21.67 respectively while those taught using simulation is 16.55 and 25.31 respectively. The mean scores of the two groups increased from pretest to posttest, showing that the all the strategies were effective in teaching the concept. Comparing the mean gain scores 8.04 and 8.76 of students taught using concept mapping and stimulating strategies respectively indicates that the use of simulation was more effective when compared to concept mapping.

Research Question Two

What is the difference between mean performance score of male and female students taught nervous coordination using simulation strategy?

Table 2: Mean and standard deviation of male and female Students' pretest and posttest scores taught using simulation strategy.

Gender	N	Pretest		Posttest		Mean Gain
		$\overline{X}$	SD	$\overline{X}$	SD	
Male	29	16.86	2.74	25.93	2.65	9.07
Female	26	16.19	2.94	24.62	2.77	8.43

As shown in Table 2, the mean performance scores of male students' pretest and posttest scores taught nervous coordination using simulation is 16.86 and 25.93 respectively while that of their female counterparts is 16.19 and 24.62 respectively. The mean scores of male and female students increased from pretest to posttest, showing that simulation was effective in teaching the concept for both male and female students. Comparing the mean gain scores 9.07 and 8.43 of male and female students taught nervous coordination using simulation respectively, it indicated that the use of simulation was more effective for both male and female students.

Research Question Three

What is the interaction effect of teaching strategies (concept mapping and simulation) and gender on students mean performance score in nervous coordination?

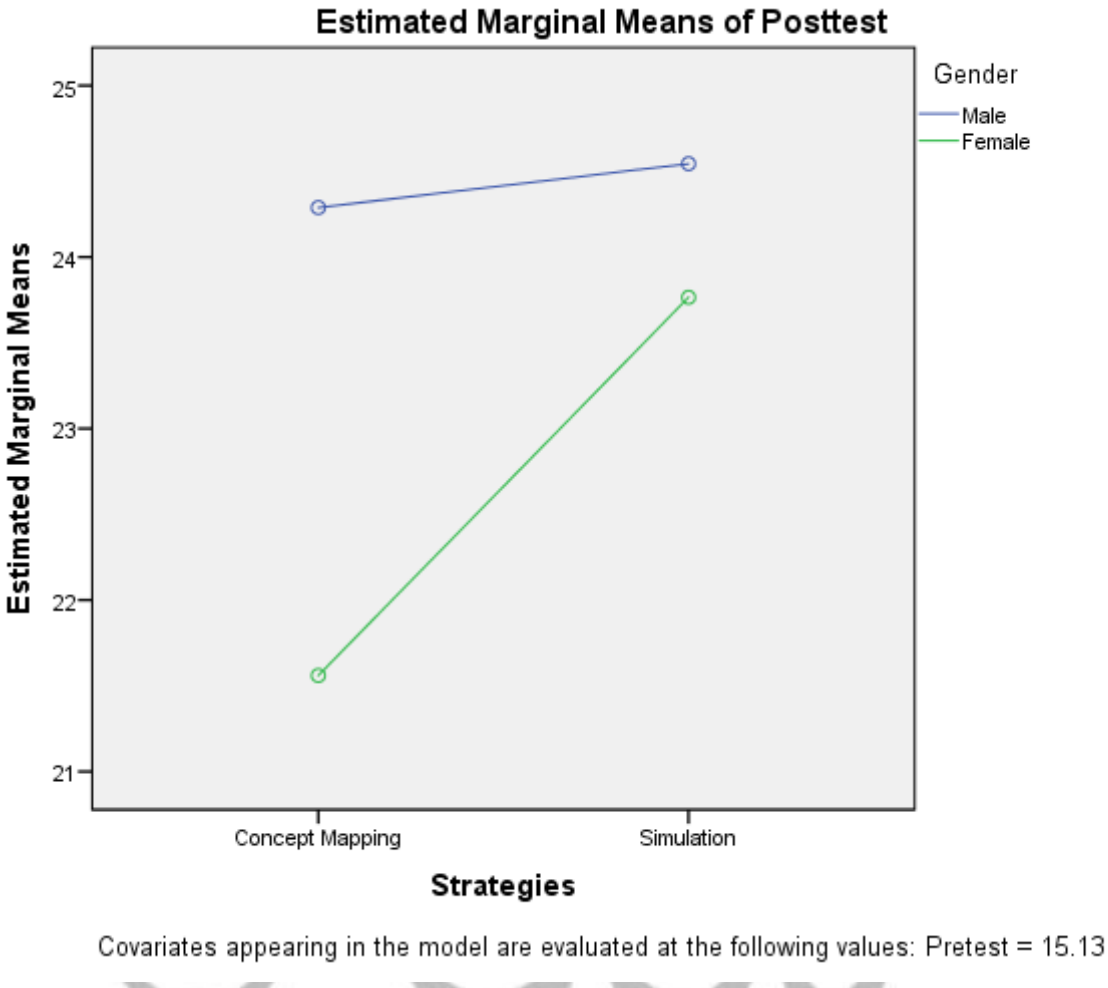

Figure 1: Interaction effect of strategies and gender on biology students' performance

As shown in Figure 1 the male students score are higher than that of the females in both strategies, however male slop is almost horizontal while that of the female students is almost vertical. The two-way interaction effect exists as the lines are not parallel therefore they would interact. The graph shows that two-way interaction effect exists.

Hypothesis One

There is no significant difference between the mean performance score of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy.

Table 3: Analysis of covariance of students posttest scores based on strategy using pretest scores as covariate.

Source of Variation	SS	Df	MS	F_{cal}	P-value$_{cal}$
Pretest	1233.64	1	1233.64	302.61	.00*
Strategy	20.96	1	20.96	5.14	.03*
Residual	423.97	104	4.08		
Total	1678.56	106	15.84		

* = Significant at .05 level of significance

As shown in Table 3, the analysis of the pretest scores of the two groups of students is significant since the calculated P-value .00 is less than the alpha (.05), indicating the groups were not comparable. The comparability of the groups is however addressed by analysis of covariance that would regress the pretest and posttest scores of the students. The table also showed that the calculated P-value (.03) of Strategy is less than the alpha level (.05). Therefore, the null hypothesis is rejected. This implies that there exists significant difference between the mean performance scores of biology students taught nervous coordination using concept mapping strategy and those taught using simulation strategy.

Hypothesis Two

There is no significant difference between the mean performance score of male and female biology students taught nervous coordination using simulation strategy.

Table 4: Analysis of covariance of students' posttest scores based on gender using pretest scores as covariate.

Source of Variation	SS	df	MS	F_{cal}	P-value$_{cal}$
Pretest	210.92	1	210.92	57.47	.00*
Gender	9.99	1	9.99	2.72	.12^{NS}
Residual	190.84	52	3.67		
Total	411.75	54	7.63		

* = Significant at .05 level of significance NS=Not significant at .05 level of significance

As shown in Table 4, the analysis of the pretest scores of the two groups of students is significant since the calculated P-value .00 is less than the alpha (.05), indicating the groups (male and female) were not comparable. The comparability of the groups is however addressed

by analysis of covariance that would regress the pretest and posttest scores of the male and female students. The table also showed that the calculated P-value (.12) of gender is greater than the alpha level (.05). Therefore, the null hypothesis is retained. This implies that no significant difference exists between the mean performance scores of male and female biology students taught nervous coordination using simulation strategy.

Hypothesis Three

There is no significant interaction effect of teaching strategies (concept mapping and simulation) and gender on students mean performance in nervous coordination.

Table 5: Analysis of covariance of students' posttest Scores based on gender using pretest scores as covariate.

Source of Variation	SS	df	MS	F_{cal}	P-$value_{cal}$
Pretest	1233.64	1	1233.64	378.04	.00
Strategies	20.96	1	20.96	6.42	.01
Gender	66.92	1	66.92	20.51	.00
Strategies*Gender	24.19	1	24.19	7.41	.01
Residual	332.85	102	3.26		
Total	1678.56	106	15.84		

* = Significant at .05 level of significance NS=Not significant at .05 level of significance

As shown in Table 5, the analysis of the pretest scores of the two groups of students is significant since the calculated P-value .00 is less than the alpha (.05), indicating the groups (male and female) were not comparable. The comparability of the groups is however addressed by analysis of covariance that would regress the pretest and posttest scores of the students. The table also showed that the calculated P-value (.01) of strategies * gender is less than the alpha level (.05). Therefore, the null hypothesis is rejected. This implies that there exists significant interaction effect of strategy and gender on biology students' performance in nervous coordination. Thus the effect of strategy and gender on each other is different at all levels of the other factor (performance).

Discussion of Findings

The findings on the difference between the mean performance score of students taught nervous coordination using concept mapping strategy and those taught using simulation strategy indicated a significant difference. Students taught using simulation performed better than those taught using concept mapping. The findings could be attributed to the ability of the students to visualize and understand the complexities underlying the concept. The findings of the study is inline with that of Adeyemo and Sreelekha (2018), who found that use of simulations significantly improved students' achievement and acquisition of skills in Practical Physics. The findings of the study is also in line with that of Reddy and Phyu (2017), who found that taught using simulations were more successful than the students of the control group who were taught by the traditional approach.

The findings on the difference between the mean performance scores of male and female students taught nervous coordination using simulation strategy indicated a non significant difference. The non-significant of gender could be attributed to computer simulation strategy, which improved the performance of both the male and female students. Hence, simulation strategy is not gender biased and does not discriminate between male and female students' performance. The finding of the study is in line with that of. The findings of the study is also in line with that of Olalekan and Oludipe (2016), who found that a significant effect on the retention ability of students but no significant effect on gender was observed.

The findings on the interaction effect of strategy and gender on biology students' performance in nervous coordination indicated a significant interaction. This indicates that the effect of strategy and gender on each other is different at all levels of the other factor (performance). The finding of the study is in-line with that of, who found. The finding of the study is contrary with that of Umoke and Nwafor (2014), who found that there was no statistically significant interaction between gender and instructional approaches on students' mean achievement scores in biology. The finding of the study is also contrary with that of Ukpai *et al.* (2016), who found no interaction between gender and teaching methods on students' achievement in basic science.

Conclusion

Based on the findings, it was concluded that simulation strategy was more effective than concept mapping strategy in enhancing students' academic performance when teaching the concept of nervous coordination. However, simulation was found effective in enhancing both male and female students' performance.

Recommendations

Based on the findings and the conclusions reached, the following recommendations were made:

1. Teachers of biology should make effective use of simulation strategy in the teaching of nervous coordination in biology to improve learning.
2. Seminars, conferences and workshops should be organized by the government for biology teachers for more enlightenment on effective utilization of computer simulation strategy.
3. Educational policy makers such as National Education Research Development Council (NERDC), Curriculum planners and Ministry of Education, should incorporate the use simulation strategy in the curriculum

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