

EFFECT OF FUTURES WHEEL AND CONCEPT MAPPING INSTRUCTIONAL STRATEGIES ON STUDENTS' ACHIEVEMENT IN BIOLOGY IN USHONGO LOCAL GOVERNMENT AREA OF BENUE STATE

BY

IORLAHA JOHN DAAGU (PhD)

National Open University of Nigeria,
Adikpo Study Centre, Benue State, Nigeria daaguji@gmail.com

AHANGBA MADUGU

Government Special Science Secondary School,
Ushongo Benue State, Nigeria

ADAKU STELLA DAAGU,

National Open University of Nigeria,
Adikpo Study Centre, Benue State, Nigeria daaguji@gmail.com

IKONDO KUMAM

Government Day Secondary School, Katsina-Ala, Benue State, Nigeria

&

EMMANUEL EGAHI

Benue State University, Makurdi, Benue State, Nigeria

ABSTRACT

This study investigated 'Effect of futures wheel and concept mapping instructional strategies on students' achievement in Biology in Ushongo Local Government Area of Benue State'. Two research questions were raised and two hypotheses were formulated for the study. The design adopted for this study was a quasi-experimental non-equivalent pre-test and post-test group design. The population of the study comprised 952 SS2 students offering Biology made up of 538 males and 414 females during the 2020/2021 academic session. Multistage sampling was used to draw 500 students for the study. The researchers constructed a Biology Achievement Test (BAT) for data collection. Mean scores and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The study found that there was a difference in the mean achievement scores of senior secondary students taught Biology with Concept mapping and Futures wheel instructional strategies and that there is the interaction effect of Concept mapping and Futures-wheel instructional strategies and gender (male and female) on students achievement in senior secondary school Biology. The study recommends that management of secondary schools should ensure that teachers are retrained in the usage of futures wheel and other model instructional strategies in the teaching so as to boost students' academic achievement in the subject.

Keywords: Effect, Futures Wheel, Concept Mapping, Instructional Strategies, Biology, Secondary Education, Benue State.

Introduction

Science is a study of nature and natural phenomenon in order to discover their principles and laws. In the views of Uwakwe, Adiniran and Fasimu (2018), science focuses on the study of the natural world based on observation and experimentation, which result in the understanding of the composition and functioning of the natural world. Science in a nutshell is positioned towards providing workable and durable solutions to the ever increasing human problems. Most developed countries of the world emphasizes the development of science and technology at all levels of the education system by making available incentives for students who are offering science subjects in the secondary schools and science based disciplines in tertiary institutions such as medicine, pharmacy, engineering, architecture and others are not less than 80% in the universities of technology. As earlier mentioned, prioritizing science education over other aspects of education is geared towards marshalling resources to provide solutions to human issues as well as resolving some nagging environmental problems.

One of the most intractable environmental problems experienced day-by-day today in Nigeria is the problem of solid waste collection and disposal in the environment. Gube (2016) found out that most Nigerian cities, towns and even the rural communities are decorated with monumental heaps of stinking solid wastes littered on the streets, markets, bus stops, motor parks and any available space. Some of the affected streets or roads have been rendered impassable for several weeks and months as a consequence or have resulted to permanent closure of such streets or roads. Where dumpsites are available, they are hardly evacuated by the authorities concerned. Same is the case where waste bins are provided they overflow the bin and form ugly heaps along the streets. In many cases however, dump sites and refuse bins are not even available and in such circumstances the waste is dumped indiscriminately anywhere and by so doing backyards, gutters, and any available space are converted into unauthorized dump-sites.

The refuse dumps form habitats for worms, flies, rates, rodents, snakes and all sorts of pathogenic micro-organisms and vermin. According to Okonkwo (2012), gases emitted from these heaps of refuse pollute the air with offensive stinking odour. It is hoped that the knowledge of biology will bring to bear the dangers of industrial pollution and assist the students to engage and educate the public on ecologically friendly practices that reduces pollution and environmental degradation. The Nigerian government has on different occasions provided various forms of incentives to lure students into science-based disciplines. For example, in provision tertiary education, the admission quota is 60% for science disciplines and 40% for the other disciplines. This is an attempt to induce academic pursuit towards sciences.

Despite these laudable socio-biological values in boosting the scientific and technological advancement as well as the educational system of the nation, there is persistent poor achievement of students in biology which is considered as the bedrock for environmental sciences that persistently provides solutions to environmental issues. Persistent poor achievement of students has been observed in Biology national and international examinations. Reports of students' achievement in Biology from WAEC have shown the following percentage failure against the corresponding years: 2009--42.11%, 2010--32.55%, 2011--43.27%, 2012--21.84%, 2013--27.28%,

2014--30.11%, 2015--38.64%, 2016--32.34%, 2017--37.19% and 2018--41.27%. This persistent poor performance might be attributed to low interest of students in the subject which leads to poor academic performance. The poor achievement may be exacerbated by gender of the students as well as the teaching methods employed in teaching the subject matter. Biology as an academic discipline in Nigerian secondary schools which is one of the subjects into which basic ecological concepts and ecological management have been infused, is plagued with such problems as poor achievement of candidates in public examinations.

Achievement according to Iwundu (2011) is academic accomplishments of students as a result of exertion of efforts, skills, perseverance and practice. It is the degree or level of success attained at the end of an academic endeavour. Corroborating this view, Uroko (2010) asserts that academic achievement of the individual is learning outcome of the individual which includes the knowledge, skills and ideas acquired and/ or gained through the course of the study within and outside the classroom situations. For example, if a student is able to pass West African School Certificate Examination (WASCE) at A, B and C levels, it can be said that the student has made success in the said examination. But if the student in question has made Ds, Es and Fs, it can be said that the student did not succeed in the said examination. This implies that the yardstick for measuring students' level of academic achievement is by assessing the academic performance of the individual through test (Ernest-Ehibudu & Oporum, 2013).

Gender is another vital variable in teaching and learning. Gender according to Uzoegwu (2004) is varied socially and culturally constructed roles, qualities and behaviours that are ascribed to men and women of different societies. Okeke (2008) refers to gender as the social or cultural characteristics, roles or behaviour which males and females are known for by society. Onyegegbu (2008) defines gender as the sum total of cultural values, attitudes, roles practices and characteristics based on sex. Thus some arguments emphasize that male read certain subjects and some others are reserved specifically for females. Thus, attributing failures or successes of students to some prejudices that some subjects are made for males (masculine subjects) while others are made for females (feminine subjects).

Students' achievement in Biology around the globe could be encouraged through futures wheel. Futures wheel is a method for graphical visualization of direct and indirect future consequences of a particular change or development. It is used for graphical visualization of direct and indirect future consequences of a particular change or development or method of teaching where the learner with minimum guidance from the teacher seeks to discover and create answers to a recognized problem through a procedure of making diligent projections of future events based on current phenomena. Concept mapping instructional strategy falls into the broad family of graphic organizing tools that include mind mapping and spider diagrams. It enables students to actively construct a conceptual framework to which new ideas and knowledge are added, related and redefined thereby improving on their learning capability and strategy.

Futures wheel differs from and is more effective in enhancing students' achievement than concept mapping in that it utilizes ideas from constructivist epistemology and Ausubel's assimilation

theory of cognitive learning and places high value on prior knowledge in the process of acquiring new knowledge (Rober, 2018). However, literature on the use of futures wheel and concept map in determining students' achievement in biology is scanty. It is against this background that the researchers undertook the study to determine the effect of futures wheel and concept mapping instructional strategies on students' achievement in basic ecological concepts and ecological management in Biology.

Statement of the Problem

There is persistent low achievement in Biology in external examinations like WAEC and NECO over the years leading to low manpower in science and technology based professionals, poor performance in Biology brings about poor enrolment in science and technology courses in tertiary institutions. Furthermore, it is the expectation of stakeholders in education like parents and policy planners that students have better achievement in all the subjects offered in secondary schools. However, this expectation seems unrealizable as students' record poor achievement in different subject areas biology inclusive. Evidence of this poor achievement of students in Biology has been documented by the West African Examination Council's (WAEC) Chief Examiners' report (2009 - 2018).

Similarly, WAEC chief examiners' report (2018) reported that students' achievements on ecological concepts were very poor. The reason for the poor achievement has been attributed mainly to teaching methods which do not give the students the ability to arrange their points in an orderly manner. However, the WEAC chief examiners' report 2017 attributes the issues of poor achievement to instructional strategy used in teaching and learning. Thus, the problem of this study put in question form is 'what is the effect of futures wheel and concept mapping instructional strategies on students' achievement in Biology in Ushongo Local Government Area of Benue State?

Research questions

The following research questions guided this study:

1. What is the mean achievement scores of senior secondary school Biology students taught with Futures-wheel strategy and those taught with Concept mapping instructional strategy?
2. What is the interaction effect of methods and gender on senior secondary school students' achievement in Biology?

Hypotheses

The following null hypotheses guided the study and were tested at 0.05 level of significance.

Ho1: There is no significant difference in the mean achievement scores of senior secondary school Biology students taught with Futures-wheel strategy and those taught with Concept mapping instructional strategy.

Ho2: There is no significant difference in the interaction effect of methods and gender on senior secondary school students' achievement in Biology.

Methodology

This section covers the research procedures employed in the study under design of the study, area of the study, population, sample and sampling techniques, instrument for data collection, validation, reliability, and method of data analysis.

Design of the study: The design adopted for the study is a quasi-experimental research design. Specifically, it employed a quasi-experimental non-equivalent pre-test and post-test group design. According to Ajev (2019), this is a research design where there is no complete randomization of subjects. This method was adopted in order to avoid disruption of school organization. Here in the study, the researchers used two streams of SS2 students as experimental groups respectively. Hence, non-equivalent intact classes were randomly assigned to the two groups.

Area of the Study: This study was conducted in Ushongo Local Government Area of Benue State. The local government area is bordered on the North by Gboko, on the east by Katsina-Ala, on the south by Kwande and on the west by Vandeikya Local Government Areas of Benue State. The area consists of civil servants, farmers, artisans, and has one of the largest land mass among Local Government Areas of the state. The local government area is inhabited mainly by indigenous Tiv speakers and some settlers who reside there mainly for business and other activities. The researchers chose the area for the study because the presence of both primary and post primary educational institutions which are both publicly and privately owned. The area is also located not far from College of Education, Katsina-Ala which produces teachers and also frequently organizes seminars, conferences and workshops for teachers' retraining. In the midst of these advantages, senior school students' achievement in Biology seems to be relatively low.

Population of the Study: The population of the study comprised 952 SS2 students offering Biology. The population was made up of 538 males and 414 females during the 2020/2021 academic session. The population was obtained from the Ushongo Area Education Office, Lessel. The area comprised Utange, Mbayegh, Mbagwaza and Mbagba kindreds. The researchers chose the population because the students in the area have been exposed to the senior secondary school Biology curriculum, other than SS1, whereas the SS3 students were writing SSCE at the time. Furthermore, they were chosen because the theme and topics covered in this study were incorporated in the SS2 scheme of work.

Sample and sampling techniques: The sample size of the study is 500, which consist of 250 male and 250 female students. The researchers in choosing the sample size of the study, considered homogeneity of subjects, cost, and adequacy. Hence, multistage sampling was used to draw the sample for the study. All the schools used for the study have enrolled students for SSCE/WASCE for at least five years and the needed sample have at least two Biology teachers in each school.

Instrument for Data Collection: The researchers constructed a Biology Achievement Test (BAT) for data collection. The BAT consisted of thirty-five (35) multiple choice-objectives questions

adapted by the researchers from the chosen theme or topics [basic ecological concepts and ecological management] as contained in the Biology SS2 syllabus. Questions from these topics were adapted from the West African Senior School Certificate Examination (WASCE) past question papers and Biology textbooks. The BAT was used for the pre-test and post-test treatments of the groups. The question numbers were reshuffled before it was later re-administered for post-post experiment.

Validation of the Instrument: The researchers submitted the instrument [BAT] for face, construct and content validity two lecturers in Science Education, one lecturer from Measurement and Evaluation, Benue State University, Makurdi and two biology teachers from Government Day Secondary schools, Katsina-Ala. Their suggestions and recommendations were used in putting up the final copy of the instrument.

Reliability of the Instrument: A trial test was conducted on 40 SS2 Biology students who were not part of the research sample. Scores generated from the trial test were used to estimate the reliability co-efficient of the instrument, using Kuder-Richardson formula twenty [K-R20]. Data analysis from the trial test gave a reliability coefficient of 0.83 and the instrument was adjudged to be reliable for the study.

Method of Data Collection: The researchers conducted a pre-test in the six sampled schools during the second week of resumption in the third term when it was discovered that all the students had resumed from the previous term's holiday. Thereafter, regular biology teachers in the sampled schools carried out normal teaching of the biology topics on both the experimental groups of the study. At the end of the seventh week of the term, a post-test was administered on the experimental groups. The questions numbers were reshuffled in an attempt to reduce pre-test-post test sensitization. The BAT scripts were marked and scored between the minimum of 0 and maximum of 100 percentage (%).

Method of Data Analysis: Mean scores and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The use of ANCOVA was due to the use of intact classes in the study; without which their initial differences cannot be guaranteed. So, ANCOVA was used to partial out the initial or inter-group differences that may have been introduced as a result of the use of intact classes.

Presentation of Results

Research question 1: What are the mean achievement scores of senior secondary school biology students taught with Concept mapping instructional strategy and those taught with Futures wheel strategy?

Table 1: Mean Achievement Scores of Senior Secondary School Biology Students taught with Concept Mapping Instructional Strategy and those taught with Futures Wheel Strategy.

Strategy	Pretest		Post test	
	Mean	SD	Mean	SD
Concept mapping	23.23	11.32	36.17	10.221
Futures wheel	29.33	14.33	47.12	16.091

Table 1 shows the mean achievement scores of SS2 students taught senior secondary school Biology with Concept mapping and Futures-wheel instructional strategies. The table shows that students achievements [posttest] scores of 36.17 is higher as against their pretest score of 23.23 in the Concept mapping strategy group. The table also revealed that a higher achievement score of 47.12 for those taught with Futures wheel strategy as against their pretest score of 29.33. This therefore, indicated a mean achievement difference of 10.95. The high achievement was as a result of using and comparing the two instructional strategies.

Ho1: There is no significant difference in the mean achievement scores of senior secondary school Biology students taught with Concept mapping instructional strategy and those taught with Futures-wheel strategy.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	34144.412 ^a	3	5812.261	44.271	.000
Intercept	217345.411	1	217345.411	318.411	.000
Pretest	38104.633	1	38104.633	44.812	.000
Strategy	462.256	1	462.256	.611	.488
Error	632410.209	496	224.661		
Total	2332560.00	500			
Corrected Total	339812.371	499			

(Significant $p < 0.05$, H_0 rejected)

Table 2: ANCOVA for the Difference in Mean Achievement Scores of Senior Secondary School Biology Students taught with Concept Mapping Instructional Strategy and those taught with Futures-wheel Strategy.

Table 2 shows the ANCOVA result for the difference in mean achievement scores of senior secondary school Biology students taught with Concept mapping instructional strategy and those taught with Futures-wheel strategy. From the table, F value (.611) is significant at .488. This level is greater than 0.05 significant level hence the null hypothesis was rejected. This implies that there is a significant difference in the mean achievement scores of senior secondary school

Biology students taught with Concept mapping instructional strategy and those taught with Futures-wheel strategy.

Research question 2: What is the interaction effect of Concept mapping and Futures wheel instructional strategies and gender on senior secondary school students achievement in Biology ?

		Concept mapping		Futures Wheel	
		Pretest	Post test	Pretest2	Posttest2
Gender*					
Male	Mean	36.16	52.61	27.11	58.23
	Std Deviation	12.381	18.941	4.712	16.734
Female	Mean	32.42	46.39	26.25	48.19
	Std Deviation	9.836	14.774	6.07	15.365
Total	Mean	34.29	49.5	26.68	53.21
	Std Deviation	11.109	16.858	5.391	16.050

Table 3: Mean Interaction Effect of Concept Mapping and Futures-wheel Instructional Strategies and Gender on Senior Secondary School Students' Achievement in Biology.

Table 3 shows the mean interaction effect of Concept mapping and Futures wheel instructional strategies on gender (male and female) senior secondary school Biology students taught basic ecological concepts and ecological management. The table reveals that male students' achievement [posttest] scores of 52.61 and 58.23 are higher than their pretest scores of 36.16 and 27.11. Similarly, it reveals that female students' achievement [posttest] scores of 49.50 and 53.21 are higher than their pretest scores of 34.29 and 26.68 respectively. The result indicates that males had higher achievements than their female counterparts. This shows that the efficacy [interaction effect] of the two instructional strategies on gender as was employed in the study.

Ho2: There is no significant difference in the interaction effect of Concept mapping and Futures-wheel instructional strategies and gender on senior secondary school students' achievement in Biology.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	51873.371 ^a	3	27118.004	44.197	.000
Intercept	201173.622	1	201173.622	317.225	.000

Pretest	21873.815	1	21873.815	62.109	.000
Strategy	16293.233	1	21873.815	48.834	.000
Error	341109.412	496	287.823		
Total	2111761.431	500			
Corrected	633482.732	499			
Total					

(Significant $p < 0.05$, H_0 rejected)

Table 4: ANCOVA Results for the Difference in Mean Interaction Effect of Concept Mapping and Futures-wheel Instructional Strategies and Gender on Senior Secondary School Students Achievement in Biology

Table 2 shows the ANCOVA results for the difference in mean achievement scores of senior secondary school Biology students taught with Concept mapping instructional strategy and those taught with Futures-wheel strategy. The table showed an F value of 48.834 that is significant at 0.000. This level is greater than 0.05 significant level thus the null hypothesis is rejected. This implies that there is a significant difference in the mean achievement scores of senior secondary school Biology students taught with Concept mapping instructional strategy and those taught with Futures-wheel strategy.

Discussion of findings

Findings from research question one shows that there was a difference in the mean achievement scores of senior secondary students taught Biology with Concept mapping and Futures wheel instructional strategies in Ushongo Local Government Area of Benue State as indicated by the standard deviation. Findings further show that the mean achievement [posttest] students score of those in Experimental Group one (EG1: Concept Mapping) were lower than their counterparts in the Experimental Group two (EG2: Futures wheel strategy). On the other hand, the hypothesis shows a significant difference in the mean achievement scores of senior secondary school Biology students taught basic ecological concepts and ecological management with Concept mapping instructional strategy and those taught with Futures-wheel strategy. This result agrees with Ujo (2017) who found out that students who were exposed to chemistry knowledge through Futures-wheel had higher achievement mean scores than their counterparts taught with concept mapping.

Findings from research question two shows the interaction effect of Concept mapping and Futures-wheel instructional strategies and gender (male and female) on students achievement in senior secondary school Biology. The result indicates that males showed higher achievement than their female counterparts in the two experimental groups. Similarly, the result of the hypothesis tested at 0.05 level of significance shows that there is a significant difference in the interaction effect of the two instructional strategies and gender on students' achievement in senior secondary school Biology. This result corroborates Ejeh (2015) findings that pedagogical strategies

Conclusion

Several studies have shown that senior secondary students poor performance in Biology has become a serious issue of public concern, especially, stakeholders in education given the fact that the subject is one of the popular senior secondary school science subjects at that level. So, this study was carried out to determine the comparative effectiveness of Concept mapping and Futures-wheel instructional strategies on students' achievement in senior secondary school Biology in Ushongo Local Government Area of Benue State, Nigeria. The conclusion drawn from the findings of the study indicated that the two instructional strategies were all effective, comparing their pretest scores, but specifically revealed that futures wheel instructional strategy was more effective due to the high achievement scores of students than their counterparts in Concept mapping instructional strategy. This was because Futures wheel was innovative and learner-centred in nature and helped in improving students achievement in senior secondary school Biology.

Recommendations

Based on the findings of this study, the researchers made the following recommendations that:-

1. efforts should be put in place by governments, school administrators and stakeholders [teacher training institutions] in the training of teachers on those innovative instructional strategies and their usage. This can be done by engaging schools and teachers in capacity-building programmes such as seminars and conferences.
2. schools should accommodate researchers, especially, those on experimental studies like this, because, exercise of this nature will impact positively on school teachers through their involvement in the coordination exercise organized by the researcher and in the proper treatment of subjects-experimentation processes.
3. there should be prompt motivation of teachers through regular promotion, improved condition of service, prompt payment of salaries, welfare benefits and other incentives.
4. Parents, guardians, private and public school administrators and governments should support students through provision of instructional materials, like textbooks, exercise books, internet facilities, audio-visual teaching-learning aids and scholarships.

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