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Effect of Utilization of Systems Thinking Learning Strategies on Students' Achievement in Agricultural Ecology in Secondary Schools in Anambra State, Nigeria

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Abstract

The Sustainable Development Goal numbers 4 and 5 clearly support improved qualitative and quantitative education in societies as well as Gender equality.This research was set out to determine the effect of utilization of systems thinking learning strategies on students' achievement in agricultural ecology in secondary schools in Anambra state. The study adopted a posttest, non-equivalent control group quasi-experimental design which involved group of students in their intact classes assigned to experimental and control groups. Three research questions were answered and three null hypotheses were formulated and tested at 0.05 level of significance. The sample size for the study was 123 students. It comprised of 22 male and 25 female students assigned to system thinking learning strategy and 32 male and 44 female students assigned to conventional learning strategy. The instrument used for data collection was Agricultural Ecology Achievement Test (AEAT). To ensure content validity of the AEAT, a Table of Specification was built for the test. The AEAT was subjected to face validation by three experts. The AEAT was trial tested and Kuder-Richardson formula 20 (k-R_{20}) was used to determine the internal consistency of the test. The reliability coefficient obtained was 0.74. A total of 50 items of the AEAT had good difficulty, discrimination and distracter indices. The AEAT was administered to the students by the research assistants (subject teachers) before and after the topic has been taught to them in their schools using the learning strategies. Pretest and posttest scores of the students were collected as data for the study. The data collected were analyzed using mean to answer the research questions while ANCOVA was used to test the three null hypotheses formulated to guide the study. Based on the data analyzed, the following findings were made: Students taught agricultural ecology with system thinking learning strategy had a higher mean achievement score than those taught with conventional learning strategy using concept mapping. Also, there was a significant difference between the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and those taught with conventional method among others. Consequently, it was recommended that agricultural science teachers in secondary schools should adopt the use of system thinking learning strategy to the teaching topic like Ecology in agricultural science; among others.

Keywords: *Gender, Sustainability, Systems Thinking and Agricultural Ecology*

Introduction

System thinking is widely used all over the world in solving complex problem. It is widely adopted and used as a management principle to solve complex organizational problem. Today, system thinking is applied in the educational industry for the teaching and learning of difficult/complex concept. The application of system thinking in the teaching and learning differs from other conventional methods in which concepts are treated in isolation rather than as a whole.

System thinking, look at the interconnectedness of concepts, topic or system. Systems thinking differ from non-systems thinking. In systems thinking the principles applying to complex systems are involved in the cognitive analysis and representation of these systems. Systems' thinking is a way of mentally framing what we see in the world. It is a way of thinking which looks at the 'whole' first with its fit and relationship to its environment as a primary concern. Attention to the constituent elements or parts of the system is secondary (Morgan, 2005). Systems thinking is more an orientation or a perspective than it is a formula or prescription. It can be used to help people understand how systems work and how people

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can deal with them more effectively. It is a way of exploring real life rather than representing it. It is a technique to figure out what's going on. It encourages people to look for patterns of interaction and underlying structures that shape the emergent patterns of systems behavior (Morgan, 2005). The focus of systems thinking moves in a variety of different directions compared to the linear style of conventional thinking. Systems thinking pay much more attention to movement and dynamics. Danowsk, (2013) said that system thinking processes help us think about influence, team work, leverage point and leadership within an organization which can they help to identify patterns in an organizational behavior and effectively adapt when one encounter complex challenges or external influences. Water Foundation (2017) stated that system thinking habits and tools help students articulate their understanding of the system they are studying when middle school students have visual tools that assist their learning and encourage them to think deeply about things that matter to them and become more motivated and engaged.

A systems learning environment is motivating and engaging for even the most nature of the system thinking tools enables students to organize and express their thinking. It improves students' ability to: connect their learning to real- world situations, solve complex problems, consider short-term, long term and unintended consequences, and apply the habits of a systems thinker to life outside the classroom and negotiate life choices as adults. The author further stated that system thinking helps to teach student how to think, and not what to think. It helps to develop independence, mature thinkers who have the tool to manage the complexity of today's systems. Water Foundation (2017) went further to explain that in a student-centered systems thinking classroom, teachers are the facilitators of thinking and learning. Students are immersed in practice fields rich in relevant problem-solving, interdisciplinary connections, thought-provoking dialogue and opportunities for in-depth synthesis and critical thinking in schools project which is focused on supporting teachers in their ability to create such desirable learning environments for children, InTeGrate (2017) enumerated reasons to incorporate system thinking into teaching to include; 1 complex problem are multidimensional.

Both the problem and the solutions cut across multiple disciplines and spheres. 2 Students tend to prefer simplified black and white explanations which may be only partially accurate. A system approach can introduce complexity in an elegant, conceptual way that student can appreciate. 3 Systems thinking offers a means to blend natural systems with human, political, cultural or economic systems. 4). Encouraging students to think from a systems point of view can encourage creative problem solving outside the usual discipline-based channel. The author further stated that the effective strategies for teaching system thinking include using computer modeling, an inquiry-based approach, role playing, using case studies, simulation, concept mapping. A concept is an idea or principle generated from a particular experience. Inomiesa (1997) stated that concept is an idea generalized from particular relevant experience. The concept can be one or many words, and can be single or complex. Concepts are connected with prepositions and arrows in a downward-branching hierarchical structure known as map. A map is a diagrammatic drawing to show areas of emphasis. These areas of emphasis can be illustrated using a preposition. A preposition is a link between concepts. The links between the concepts can be one-way, two-way, or non-directional when several concepts are arranged on a page and linked by prepositions, which constitute a concept map.

Concept mapping is a diagram showing relationships between ideas. According to Osinem (2008) concept map is an instructional working instrument for organizing and representing knowledge. A concept map presents the relationships among a set of connected knowledge and ideas. The relationship between concepts is articulated in linking phrases, eg. "give rise to", "results in", "is required by" or "contributes to"(Novak and Godwin, 1996). Concept mapping as stated by Ezeudu (1995) is a way of representing knowledge hierarchically as a structural representation consisting of nodes and labels. The author conceives concept map as an instructional technique that systematically link new concepts to old ones in logical sequence from simple to complex, known to unknown using labels. Concept mapping technique as stated by Ahiakwo (2001) has become a viable educational tool/medium to help teachers become more effective, foster curriculum development and promotes students hands-on activity. Bayerbach and Smith (2002) in their study employed concept mapping to help teachers become effective in their teaching. Concept mapping as stated by Moreieca (2003) was used as an evaluation tool. It encourages students to learn different concepts. It is based on the idea that meaningful learning occurs when new knowledge is consciously, explicitly and deliberately linked with relevant concepts which the learner already knows. Concept mapping in this study was used to compare the effectiveness of two learning strategies (system thinking and conventional learning strategies) on students' achievement in agricultural ecology using concept mapping in secondary schools in Anambra state. Ecology is the scientific study of interaction between organisms and their environment. Begun, Townsend and Harper (2006) opined that ecology is the scientific study of the distributions, abundance and relationship of organisms and their interaction with each other in a common environment. Pollan (1993) described the importance of studying ecology as to help one understand the impacts of human action on the environment.

The study of ecological processes that operate in agricultural production systems is termed agricultural ecology (agro- ecology). The prefix agro refers to agriculture. United States Department of Agriculture,

USDA (2015) stated that agro ecology is the science of applying ecological concepts and principles to the design, development, and management of sustainable agricultural systems. It further stated that agro ecology is the science of sustainable agriculture; the methods of agro ecology have as their goal achieving sustainability of agricultural system balanced in all spheres. USDA (2015) went further to state that the main aim of studying agricultural ecology is to understand the complex processes in agric-ecosystems (a unit including all the organisms in a given area interacting with the physical environment) on high hierarchical level using general ecological theory, resulting in design and management of sustainable agricultural systems. Application of this knowledge can lead to the development of more sustainable agricultural ecosystems in harmony with their larger eco-region.

Achievement is a term used to indicate the degree of success attained in some general or specific area. Obodo (1999) stated that achievement is the extent or degree of attainment of students in tasks, courses, or programmes to which they were sufficiently exposed. Anene (2005) asserted that achievement is quantified by a measure of the student's academic standing in relation to those of other students of his age. Students' achievement connotes performance in school subject as symbolized by a score or mark on a test or examination. Information gathered from the schools in the study area shows that agricultural ecology is one of the difficult areas of agriculture and students experience difficulty in understanding and assimilating its content because of its abstract nature. This leads to low achievement level of students in examinations involving the concepts because the students are not sufficiently challenged to be at the centre of instruction through carrying out activities. The conventional teaching techniques used by the teachers such as planned repetition, demonstration, use of examples, questioning among others could not help increase the achievement level of students in agro ecology. Also the conventional learning strategy used by the students in learning agro ecology and their gender differences could contribute to the low level achievement of students in the study area. Thus research is needed to determine whether the use of concept mapping teaching technique together with the conventional teaching techniques with system thinking and conventional learning strategies would have differential effects on male and female students' achievement in agro ecology. This study is therefore designed to determine gender and sustainable issues in the utilization of systems thinking learning strategies on students' achievement in agricultural ecology in Anambra State, Nigeria.

Purpose of the Study

The Major purpose of the study is to determine effect of utilization of systems thinking learning strategies on students' achievement in agricultural ecology in Anambra State Nigeria.

Specifically, the study sought to determine:

1. the instructional learning strategy that can improve achievement scores of students taught agricultural ecology with system thinking learning strategy and those thought with conventional learning strategy using concept mapping.

2. the influence of gender on the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and conventional learning strategy using concept mapping.
3. the interaction effect of gender and the learning strategies on students' achievement in agricultural ecology using concept mapping.

Research Questions

The following research questions were posed and answered:

1. Which of the system thinking learning strategy and conventional learning strategy using concept mapping has the capacity of improving students achievement in Agricultural ecology?
2. What is the influence of gender on the mean achievement scores of students (male and female) taught agricultural ecology with system thinking and conventional learning strategies using concept mapping?
3. What is the interaction effect of gender and learning strategies on students' achievements in agricultural ecology using concept mapping?

Hypothesis

The following hypothesis guided the study and were tested at 0.05 level of significant

Ho_1: There is no significant difference in the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and those taught with conventional learning strategy using concept mapping.

Ho_2: The mean achievement scores of male and female students taught agricultural ecology with system thinking learning strategy and conventional learning strategy using concept mapping do not differ significantly

Ho_3: There is no significant interaction effect of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping

Methodology

The study adopted quasi-experimental design. Specifically, it is a pretest, posttest, non-equivalent control group design. The design was adopted because it is not possible to have complete randomization of subjects. The design according to Ali (2006) is considered

appropriate because it establishes a cause and effect relationship between the independent and dependent variables. In this design, intact classes (non-randomized groups) were used as experimental and control groups. The study was carried out in Anambra state. The state is made up of six education zones namely Awka zone, Ogidi zone, Nnewi zone, Otuocha zone, Onitsha zone and Aguata zone. The study covered Ogidi education zone which comprises of three local governments; Idemili south, Idemili north and Oyi.. The area is considered suitable for this study because of the low level of achievement of agricultural science students in agricultural ecology.

The population for this study comprised of 1327 made up of all the 2016/2017 year one Senior Secondary (SS1) agricultural science students in Ogidi Education Zone of Anambra State (Post Primary School Service Commission PPSSC Ogidi Zone, 2015). A multi stage sampling technique was used to select the sample for this study. There are 40 secondary schools in Ogidi Education Zone of Anambra State, 27 out of it offers agricultural science. Eleven from Idemili North, Eight from Idemili south and Eight from Oyi local government (PPSSC Ogidi Zone, 2015). Considering the gender issue in the study, purposive sampling technique was used to select 10 co-educational schools from the 27 secondary schools offering agriculture in the zone. Thereafter, four (4) secondary schools were randomly selected through sampling with replacement from the co-educational schools. The first two schools selected were assigned to system thinking learning strategy while the other two was assigned to conventional learning strategy. Then intact classes of the four schools were randomly assigned through balloting. In all 123 students were used as sample for the study. It comprised of 22 male and 25 female assigned to system thinking learning strategy making a total of 47 students and 32 male and 44 female assigned to conventional learning strategy making a total of 76 students. The instrument for data collection was a 50 multiple choice test items on Agricultural Ecology Achievement Test (AEAT) developed by the researcher using the curriculum of agricultural science for senior secondary school 1 to get the topics taught by the teacher to the students under agricultural ecology, and duly validated by three lecturers from the Department of Agric and Bio-resources Education, University of Nigeria Nsukka.

The reliability was established using Kuder-Richardson formula 20 ($k = R_{20}$) which yielded a reliability index of 0.74. The formula according to Nworgu (2006) is used when test items are scored A or B (eg. Right or wrong) or an untimed test assumed to measure one characteristic or quality. It is therefore suitable for multiple choice questions. The teaching was done by the research assistants (subject teachers) using the lesson plan prepared by the researcher. The researcher before commencing with the experiment liaised with the principals of each of the schools on the aims and objectives of the research. The principals then introduced her to the head teachers of agriculture in the schools. This was to ensure a cordial working relationship between the researcher and the research assistants. The researcher instructed the research assistants on how to teach agricultural ecology concepts following the lesson plan for each of the group. Concept mapping technique was employed in the study under system thinking strategy only while conventional strategy was taught without applying any concept mapping technique. Pretest was administered to all the groups before the commencement of the treatment. The experiment lasted for five weeks after which the research assistants administered the posttest to the students in the four schools. The question numbers were reshuffled by the researcher after the pretest to avoid pretest sensitization before being used for the posttest. The researcher marked and recorded the students' scores for both pretest and posttest. The data collected from the pre-test and post-test were analyzed using mean and standard deviation to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The decision for answering the research questions was based on the mean gain scores.

Research Question 1

Which of the system thinking learning strategy and conventional learning strategy using concept mapping has the capacity of improving students' achievement in Agricultural ecology?

The data presented in Table 1 shows that students taught agricultural ecology with system thinking learning strategy had a mean score of 23.8 with SD of 7.4 in the pretest and a mean score of 37.0 with SD of 6.1 in the posttest and with a mean gain of 13.2.

Table 1 Mean and Standard Deviation Scores of Students Taught Agricultural Ecology with System Thinking Learning Strategy and Conventional Learning Strategy using Concept Mapping

Variable		Pre test		Post test		Mean gain
Learning strategies	N	$\bar{x}$	SD	$\bar{x}$	SD	
System thinking	47	23.8	7.4	37.0	6.1	13.2
Conventional with concept mapping	76	19.1	6.9	30.8	6.7	11.8
Total	123	20.9	7.4	33.2	7.1	12.3

The students taught agricultural ecology with conventional learning strategy had a mean score of 19.1 with SD of 6.9 in the pretest and a mean score of 30.8 with SD of 6.7 in the posttest and with a mean gain of

11.8. From these results, it can be seen that students taught agricultural ecology with system thinking learning strategy had a higher mean achievement score than those taught with conventional learning strategy using concept mapping.

Research Question 2

What is the influence of gender on the mean achievement scores of students (male and female taught agricultural ecology with system thinking and conventional learning strategies using concept mapping.

Table 2 Mean and Standard Deviation Scores of Male and Female Students Taught Agricultural Ecology with System Thinking and Conventional Learning Strategies using Concept Mapping

Learning Strategies	Gender	N	Pretest $\bar{x}$	SD	Posttest $\bar{x}$	SD	Mean gain
System thinking	Male	22	26.3	6.8	39.0	5.6	12.7
	Female	25	21.7	7.3	35.2	6.1	13.5
Conventional with concept mapping	Male	32	17.8	7.3	29.7	7.2	11.9
	Female	44	20.0	6.4	31.7	6.1	11.7

The data presented in Table 2 shows that for system thinking strategy, the male students had a mean score of 26.3 with SD of 6.8 in the pretest and a mean score of 39.0 with SD of 5.6 in the posttest; making a mean gain of 12.7. Also, the female students in system thinking learning had a mean score of 21.7 with SD of 7.3 in the pretest and a mean score of 35.2 with SD of 6.1; making a mean gain of 13.5. On the other hand, for conventional study group, the male students had a mean score of 17.8 with SD of 7.3 in the pretest and a mean score of 29.7 with SD of 7.2 in the posttest; making a mean gain of 11.9. Also, the female students in conventional learning had a mean score of 20.0 with SD of 6.4 in the pretest and a mean score of 31.7 with SD of 6.1 in the posttest; making a mean gain of 11.7. In conventional learning strategy, female students achieved higher than the males in system thinking learning, while male students achieved higher than the females in conventional learning strategy. This result indicates that there was no influence of gender on the mean achievement scores of students in agricultural ecology with system thinking and conventional learning strategies using concept mapping.

Research Question 3

What is the interaction effect of gender and learning strategies on students' achievements in agricultural ecology using concept mapping?

Table 3 Mean and Standard Deviation Scores of Interaction effect of Gender and Learning Strategies on Students' Achievement in Agricultural Ecology using Concept Mapping?

Gender	Learning Strategies	N	Pretest $\bar{x}$	SD	Posttest $\bar{x}$	SD	Mean gain
Male	System thinking	22	26.3	6.8	39.0	5.6	12.7
	Conventional using concept mapping	32	17.8	7.3	29.7	7.2	11.9
Female	System thinking	25	21.7	7.3	35.2	6.1	13.5
	Conventional using concept mapping	44	20.0	6.4	31.7	6.1	11.7

The data presented in Table 3 shows that male students in system thinking learning strategy had a mean score of 26.3 with SD of 6.8 in the pretest and a mean score of 39.0 with SD of 5.6 in the posttest; making a mean gain of 12.7. Also, male students in conventional learning had a mean score of 17.8 with SD of 7.3 in the pretest and a mean score of 29.7 with SD of 7.2 in the posttest; making a mean gain of 11.9. On the other hand, female students in system thinking learning strategy had a mean score of 21.7 with SD of 7.3 in the pretest and a mean score of 35.2 with SD of 6.1 in the posttest; making a mean gain of 13.5. Also, female students in conventional learning had a mean score of 20.0 with SD of 6.4 in the pretest and a mean score of 31.7 with SD of 6.1 in the posttest; making a mean gain score of 11.7. From these results, it can be seen that the mean gain score of males in the system thinking learning strategy is higher than that of the males in the conventional learning. Also, the mean gain score of females in the system thinking learning is higher than that of the females in the conventional learning. This indicates that gender and learning strategies interacted to affect students' mean achievement when taught agricultural ecology using concept mapping teaching strategy. The system thinking learning strategy is therefore superior to the conventional teaching strategy for both male and female students.

Hypothesis

Ho_1: There is no significant difference between the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and those taught with conventional learning strategy using concept mapping.

Table 4 Analysis of Covariance (ANCOVA) for Mean Achievement Scores of Students Taught Agricultural Ecology with system Thinking Learning Strategy and Those Taught with Conventional Learning Strategy using Concept Mapping

Source	Type III Sum Squares	ofdf	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5084.510[a]	2	2542.255	291.222	.000	.829
Intercept	3167.946	1	3167.946	362.896	.000	.751
Pretest	3986.200	1	3986.200	456.629	.000	.792
learning strategy	134.657	1	134.657	15.425	.000	.114
Error	1047.555	120	8.730			
Total	141535.000	123				
Corrected Total	6132.065	122				

a. R Squared = .829 (Adjusted R Squared = .826) Significant at sig of F < .05

The data presented in Table 4 shows that with respect to the mean achievement scores of students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping-ratio of 15.425 was obtained with a significance of F at .000. Since .000 is less than .05, the null hypothesis is therefore rejected at .05 level of significance. With this result, there was a significant difference between the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and those taught with conventional learning strategy using concept mapping. The partial Eta Square of. 0.7 to 0.8 implies that there is a moderate effect on the achievement of student using concept mapping.

Ho_2: The mean achievement scores of male and female students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping do not differ significantly.

Table 5 Analysis of Covariance (ANCOVA) For Mean Achievement Scores of Male and Female Students Taught Agricultural Ecology with system Thinking and Conventional Learning Strategies using Concept Mapping

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4949.989[a]	2	2474.995	251.252	.000	.807
Intercept	3105.990	1	3105.990	315.309	.000	.724
Pretest	4942.220	1	4942.220	501.716	.000	.807
Gender	.135	1	.135	.014	.907	.000
Error	1182.076	120	9.851			
Total	141535.000	123				
Corrected Total	6132.065	122				

a. R Squared = .807 (Adjusted R Squared = .804) Significant at sig of F < .05

The data presented in Table 5 shows that with respect to the mean achievement scores of male and female students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping, an F- ratio of .014 was obtained with a significance of F at .907. Since .907 is higher than .05, the null hypothesis on influence of gender on the treatment is accepted. Hence, there was no significant difference between the mean achievement scores of male and female students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping. The Eta Square of 0.8 indicates large effect on the achievements of student using concept mapping.

Ho_3: There is no significant interaction effect of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping.

Table 6 Analysis of Covariance (ANCOVA) For Interaction Effect of Gender and Learning Strategies on Students' Mean Achievement Scores in Agricultural Ecology using Concept Mapping

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1343.301[a]	3	447.767	11.127	.000	.219
Intercept	131753.054	1	131753.054	3274.042	.000	.965
Gender	22.582	1	22.582	.561	.455	.005
learning strategy	1186.453	1	1186.453	29.483	.000	.199
gender * learning strategy	243.397	1	243.397	6.048	.015	.048
Error	4788.764	119	40.242			
Total	141535.000	123				
Corrected Total	6132.065	122				

a. R Squared = .219 (Adjusted R Squared = .199) Significant at sig of F < .05

The data presented in Table 6 shows that with respect to the interaction effects of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping, an F- ratio of 6.048 was obtained with a significance of F at .015. Since .015 is less than .05, the null hypothesis is therefore rejected at .05 level of significance. With this result, there was a significant interaction effect of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping and eta square of 0.1 to 0.4 shows little effect of concept mapping on achievement of students investigated.

Discussion of the Results

The data presented in table 1 provided answer to research question one; finding revealed that students taught agricultural ecology with system thinking learning strategy had a higher mean achievement score than those taught with conventional learning strategy using concept mapping. At the same time, analysis of covariance was used to test the first hypothesis which was formulated from research question one, Table 4. At the calculated F-value (15.425), significance of F (.000) and confidence level of .05, there was a significant difference between the mean achievement scores of students taught agricultural ecology with system thinking learning strategy and those taught with conventional learning strategy using concept mapping. The implication of this finding is that system thinking learning strategy is more effective than conventional learning strategy in enhancing students' achievement in studying agricultural ecology. This finding compared favorably with the finding of Bitrus (2014) who studied the effects of cooperative and competitive learning modes on pre-school students' cognitive achievement in biology using concept mapping. The study revealed that students who were taught with cooperative learning made statistically significant improvement in their test scores than those in competitive learning. This finding is also in line with the view of Seweje and Olojo (2011) on effects of cooperative, competitive and individualistic instructional strategies on students' achievement in mathematics. The study revealed that concept learning group ranked best among the treatment group. It can therefore be concluded that engaging students in cooperative learning helps to foster team work and development of higher-level thinking skill thus enhancing their achievement than when they learn in a competitive environment.

The data presented in table 2 provided answer to research question two; finding revealed that there was no influence of gender on the mean achievement scores of students in agricultural ecology with system thinking and conventional earning strategies using concept mapping. The finding indicates that female students in system thinking learning strategy achieved higher than the males while male students in conventional learning strategy achieved higher than the females. Analysis of covariance was employed to test the second hypothesis which was formulated from research question two, Table 5. At the calculated F- value (.014) with a significance of F at (.907) and confidence level of .05, there was no significant difference between the mean achievement scores of male and female students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping. This means that the observed difference in the mean achievement scores of male and female students was not statistically significant. The differences in the achievement of male and female students could be as a result of the learning strategy exposed to them and not necessarily their gender. This finding is not far from Awolanti and Abimbola (1997) that the achievement of boys and girls did not differ significantly in ecology test in Nigerian secondary school. The data presented in table 3 provided answer to research question three; finding revealed that gender and learning strategies interacted to affect students' mean achievement when taught agricultural ecology using concept mapping. The findings indicate that male students in system thinking learning achieved higher than the males in conventional learning. Also the female in system thinking learning achieved higher than the females in conventional learning. This shows that system thinking learning strategy is superior to the conventional one for both male and female students.

However, analysis of covariance was used to test the third hypothesis which was formulated from research question three, Table 6. At the calculated F- value (6.048) with a significance of F at (.015) and a confidence level of .05, there was a significant interaction effect of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping. This result showed that the achievement of students is as a result of the interaction effect of two independent variables (gender and learning strategies). Hence, there was a differential effect of treatment (learning strategies) over levels of gender (male and female), which implies that system thinking learning strategy is more effective than the conventional learning strategy in improving students' achievement in agricultural ecology regardless of gender levels. This finding is in agreement with Uzoagulu (2011) that in an experimental study that involves multi-variables, it is pertinent to analyze the interaction effects of some variables. This is because two independent variables in combination may have an effect which cannot be accounted for by the effects of the two independent variables taken separately.

Conclusion

Agricultural ecology subject are usually taken to be a difficult aspect of agriculture due to methods adopted in teaching it to the students. The perceptions of students regarding Agricultural ecology made them to perform poorly in the course. This poor performance and interest of the students in Agricultural ecology may have been one

of the factors that had been affecting the production of skilled manpower for the Nigeria agricultural sector. The conventional lecture method employed by most teachers for instructional delivery seem ineffective for equipping students for better academic performance and interest in agriculture. To overcome this poor performance of students in agricultural ecology to enhance sustainability, this study was carried out to investigate the effect of utilization of systems thinking learning strategies on students' achievement in agricultural ecology in Anambra State, Nigeria. The study outlined the differences in the achievement of students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping, the influence of gender on the achievement of students, the interaction effect of gender and learning strategies on students' achievement. The study revealed a significant difference between the mean achievement scores of students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping. It was found out that no significant difference existed between the mean achievement scores of male and female students taught agricultural ecology with system thinking and conventional learning strategies using concept mapping, also there was a significant interaction effect of gender and learning strategies on students' mean achievement scores in agricultural ecology using concept mapping in secondary schools in Ogidi Education Zone of Anambra State. It is believed that as a result of the findings from this study, the system thinking learning will not only enhance students' achievement in agricultural ecology but will also enable them to develop higher level thinking skills in problem solving.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Since the use of system thinking learning strategy enhances academic performance of students in agricultural ecology, teachers should adopt the use of this technique for instructional delivery in their schools.
2. Seminars, workshops and conferences should be organized by the state ministry of education where teachers and curriculum planners will be taught the application and usage of various modern teaching techniques such as system thinking for effective teaching and learning of agricultural science in secondary schools.

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