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ENHANCING UNIVERSITY STUDENTS' ECOLITERACY THROUGH CONCEPT MAPPING INSTRUCTIONAL STRATEGY

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ABSTRACT: *Lives on earth solely depend on the environment for food, shelter and production of the next generation. Ecologically literate society ensures the sustainability of a healthy environment for future generations. This study aimed at enhancing the ecoliteracy of university students through concept mapping. To achieve that, four research questions and hypotheses were answered and tested respectively. Quasi-experimental design, involving experimental and control groups, was employed. 210 students were selected from four programmes in the two universities in Sokoto State, Nigeria using convenient and random sampling techniques. The ecological knowledge and Thinking Test was used for data collection. The statistical tool used for data analysis was independent t-test. The study found that both concept mapping and lecture methods enhanced students' ecological knowledge, but concept maps enhanced students' critical thinking more than lecture methods. Thus, the study recommends the use of concept mapping during ecoliteracy training designed to promote ecological critical thinking.*

KEYWORDS: Ecoliteracy; Concept Mapping; University Students.

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INTRODUCTION

Environment is the most pivotal component of the universe which provides man with all the necessary materials needed for his survival and his lineage. Man depends on the environment for food, shelter, oxygen, etc.; yet, he destroys the environment. His remarkable development in science and technology, coupled with high population growth and the frequent exploration of natural resources are resulting in several environmental issues such as erosion, drought, climate change, increase in environmental temperature, etc. These affect every continent and country in the world and have been profoundly explained in the existing literature. Dan (2019) reported that the Sahel region of Africa is the most affected part of the world in the dwindling of natural resources. In Nigeria, the major causes of these environmental issues or problems have been identified as urbanization, overpopulation, deforestation, desertification and pollution (Isife, 2012). Therefore, improving the environment is the responsibility of all members of the society, including educational institutions, teachers and students.

There has been an increasing concern over ecological literacy in society. Literature on ecological literacy emphasizes the role of critical thinking in identifying cause-effect relationships in socio-environmental systems, in order to allow more enlightened decision-making (Lewinsohn et al., 2014). Ecoliteracy is meant to enable conscious citizens to make informed decisions and take action on environmental issues (Cid & Pouyat, 2013). The term ecoliteracy was first coined by Capra in 1997, and was defined as an understanding of the principles of the organization of ecosystems and the application of those principles for creating sustainable human communities and societies (McBride et al., 2013). The idea of using natural resources to ensure future availability is central to ecoliteracy. It is used synonymously with ecological literacy and environmental literacy because it is believed to have evolved from the two concepts that were used in relation to creating environmental awareness. Locke, Russo and Mantoyo (2013) believed that ecoliteracy is thus defined as not only the ability to identify, classify, and name different aspects of the environment, but includes the ability to take action and participate in the decision-making process of environmental problems and issues. It also relates to the understanding of ecological relationships and interactions and the long term impact of human activities on the environment (Locke, Russo & Mantoyo, 2013). The relationship between man and his environment is of paramount importance to his survival individually, or within communities and societies. Therefore, to maintain this relationship, man needs to know and understand the environment and how it functions and supports life (Capra, in Sheryn, Christopher, & Paul 2017). According to Roth in Locke, Russo and Mantoyo (2013), ecoliteracy revolves around acquisition of ecological knowledge, evaluating the knowledge and using the knowledge to take actions on different ecological issues. Furthermore, Okur-Berberoğlu (2018) identified ecological intelligence among the subsets of ecoliteracy; according to him, it relates to people's awareness to think critically about their environment.

Considering the importance of ecoliteracy and the need for ecologically literate society, the Nigerian government through the National University Commission, introduced a general and compulsory course titled Environmental Education and Sustainable Development (Federal Republic of Nigeria, 2014). The objective of the course among others is to provide every person with opportunities to acquire knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment for sustainable development. One common problem associated with most university campuses in Sokoto State is poor waste management especially in and around students' hostel which often results in the pollution of the hostel environment and blockage of drainages. This may make someone to wonder if members of the university

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community are actually ecologically literate considering their exposure to learning experience relating to ecological management and environmental protection, hence the need to investigate the reason for these problems with a view to solving them.

The dominant method of instruction used in Nigerian universities is the lecture method. Evidence from educational research revealed that this method affects attention, motivation and low academic performance of the learner (Snezana, Gudevab, & Djokicb, 2011). Consequent upon this and the availability of new instructional strategies such as concept mapping which were found to be effective in promoting meaningful learning, students understanding, there is the need to investigate its effect in promoting ecoliteracy among university students.

Concept mapping is one of the 20th century learning strategies developed by American science educator Joseph D. Novak in the 1970s. It was developed as a means of representing the emerging science knowledge of students. Concept mapping involves arranging concepts hierarchically with the most general, most inclusive concept at the top and the most specific, least general concepts toward the bottom, with cross-links showing relationships between concepts in two different areas of the map usually with short phrases (Novak & Cañas, 2006). This tool has now become a powerful knowledge representation tool useful not only in education but in virtually every sector of human activity (Novak & Canas, 2014). Jinchao (2004) held that concept mapping is very helpful for teachers and students to generate and communicate complex ideas, integrate new and old knowledge, design a complex structure and assess understanding or diagnose misunderstanding. He added that the strategy can be used in the teaching of the ecosystem concept and the relationships between organisms, environment and human beings, because it helps the students to understand the concepts and principles of their discipline and apply the knowledge to all aspects of their life. It is therefore the interest of this research to investigate the effectiveness of this method on enhancing students' ecoliteracy.

Research Questions

The main objective of this study is to investigate the effectiveness of concept mapping in improving university students' ecoliteracy. In an attempt to achieve this objective, the study answered raised the following research questions:

1. Is there any difference between the ecological knowledge of university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria?
2. Is there any difference between ecological thinking university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria?
3. Is there any difference between ecological knowledge of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria?
4. Is there any difference between ecological thinking of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria?

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Null Hypotheses

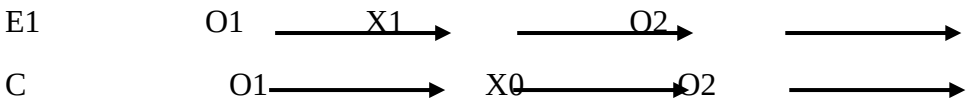
Based on the research questions raised for this study, the following hypotheses were put forward with a view to testing them:

1. There is no significant difference between the ecological knowledge of university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria
2. There is no significant difference between ecological thinking of university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria
3. There is no significant difference between ecological knowledge of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria
4. There is no significant difference between ecological thinking of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria.

RESEARCH METHODOLOGY

Design

This study embraces quasi-experimental design involving experimental and control groups. It is characterized by the administration of pretest and posttest to both groups, administration of treatment to the experimental group and sometimes to the control group, and nonrandom assignment of subjects into experimental and control groups. The design for this study is briefly illustrated as follows:



where:

E = Experimental group

C = Control Group

X1 = Concept Mapping Instruction

X0 = Lecture Method of Teaching

O1 = Pretest

O2 = Posttest

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Participants

The population for this study consists of all 300 level students from the two Universities in Sokoto state, namely: Usmanu Danfodiyo University, Sokoto and Sokoto State University, Sokoto. The two universities are located at two different local governments: Wamakko and Bodinga respectively. The students were targeted because it is believed that they took a course titled "Environment and Sustainable Development" at 200 level; thus, the ecological knowledge is assumed to be fresh in their memory.

The sample size of 210 was determined using the G power sample size calculator after identifying the independent t-test as an appropriate statistical tool for data analysis at 0.05 significance level. The sampling procedures used in this study are multistage sampling and convenient sampling techniques. In order to have appropriate samples, two faculties were selected randomly in each university. In each faculty, students from one department or programme were selected and used as an experimental group and control group. To ensure gender balance, convenient sampling was used to select departments or programmes with even gender distribution among students. Later, students in one university were assigned to the experimental group while those in the second university were assigned to the control group. This was done after folded papers labeled experimental and control were selected for each university by a primary school aged child who had no idea of the purpose and intention of the study.

Instrumentation

Two instruments/materials were developed and used in this research. The first was the Concept Mapping Guide used as a treatment material for the students in the experimental group; the second titled Ecological Knowledge and Thinking Test was used for data collection. In designing Concept Mapping Guide, several concept maps describing the content of selected topics were designed using Microsoft VISIO application. Prior to that, an account was created with the cmap tool (website with templates of concept maps). Templates of concept maps were studied before designing various concept maps illustrating contents of various ecological topics selected for this research. The maps highlighted some concepts, relationships, hierarchy, with cross links, prepositions, and specific examples where necessary. The Ecological Knowledge and Thinking Test was designed to assess the level of ecological knowledge and thinking of the respondents. It was a multiple choice test consisting of 30 items based on the content of the topics treated during the ecoliteracy training with the participants in the two universities where this study was conducted. It was divided into two sections (A and B). Section A comprised 15 questions which aimed to identify ecological knowledge of the respondents; such questions requested the respondents to recall, recognize and identify ecological concepts, phenomenon and issues. Items in Section B were equally 15 in number; they were set to measure the level of participants ecological thinking; such questions requested the participants to analyze and evaluate typical ecosystems such as ponds, rivers, farmlands and their immediate environments, to relate the impact of human activities on nature and environmental challenges like pollution, global warming, climate change, loss of biodiversity etc.

The content validity of EKTT was ascertained through a table of specification and expert face validation. Firstly, a table of specification was developed to ensure that all questions were within the content of the topics taught during training and were in line with the objectives set for each topic. Secondly, 50 items EKTT test together with the table of specification were

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presented to the test and measurement experts and experienced biology environmental educators for face validation. Furthermore, a Research Instrument Validation Form was also administered to the validators, to report their assessment and comments about the instrument. The use of simple language, reducing the number of questions, modification of some questions and sufficient instructions are among the observations raised during face validation. All corrections and observations were effected before pilot study to ascertain the reliability of the instrument.

The reliability index of EKTT was ascertained after pilot study; 20 students were voluntarily selected at Sokoto State University and a test-retest method of estimating reliability was used. The scores of the first test were compared with those of the second test by using Pearson Product Moment Correlation with the help of SPSS statistical software and a coefficient of 0.68.

Method of Data Collection

This study used two groups of subjects which were an experimental group and a control group. The experimental group was given ecoliteracy training using Concept Mapping learning strategy. The control group were given the same training using conventional lecture methods. The first activity carried was the pre-ecoliteracy training exercise. During this period, the researchers and four assistant researchers engaged in venue and students' preparation as well as administration of Ecological Knowledge and Thinking Test as pre-test to all students in the two groups. The second activity was one week of ecoliteracy training. During this period, both groups were exposed to various ecological concepts, issues, principles and challenges. A week letter, another EKTT was re-administered to all students in the two groups as post-test.

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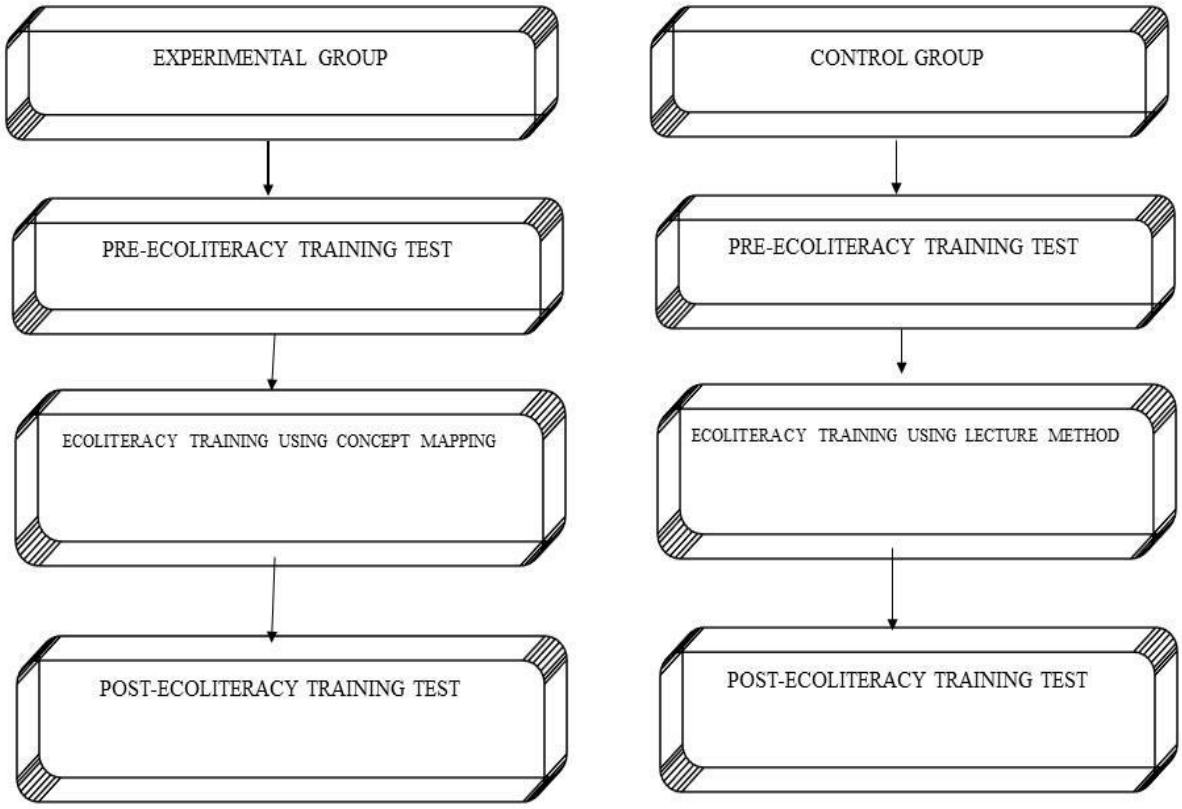
Figure 2: Experimental Procedure



Method of Data Analysis

The statistical tools used for data analyses in this research include both descriptive and inferential statistics. The descriptive statistics involving simple percentage, mean and standard deviation were used to answer all research questions raised in this study. The inferential statistics employed for testing the null hypotheses formulated in this study was independent sample t-test at 0.05 level of significance. All the data analyses were carried out using Statistical Package for Social Science (SPSS) software.

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RESULTS

Data obtained from the EKTT were presented in four tables (Table 1-4). Each table shows the data for one research question and corresponding hypothesis. For instance, Table 1 for Research Question 1 and Hypothesis 1, Table 2 for Research Question 2 and Hypothesis 2, and so on.

Table 1: Descriptive statistic and t-test result of students' ecological knowledge

Group	N	Mean	Standard Deviation	Mean Difference	t-value	P-Value
Experimental Group	105	10.78	1.44	0.34	1.60	0.11
Control Group	105	10.44	1.64			

Source: *Field work (2022)*

$\alpha = 0.05$

Table 1 above shows the descriptive statistics and t-test result of students' post-test scores from the section A of the EKTT which measured their ecological knowledge after going through ecoliteracy training. The results revealed that students in the experimental group who were trained using concept mapping instructional strategy have a score 10.78 and standard deviation 1.44. On the other hand, students in the control group who received ecoliteracy training using the lecture method of instruction have a mean score 10.44 and standard deviation 1.64. Thus, the mean difference between the two groups is 0.34 in favor of students in the experimental group. This answered research question one which sought for the difference between the ecological knowledge of university students exposed to Concept mapping and those with the lecture method in Sokoto State, Nigeria. Furthermore, the table shows that the p-value (0.11) is greater than the alpha value (0.05) set for this research, and the t-value (1.60) is less than the critical value (1.97) at 0.05 alpha value, estimated by G-power calculator in Figure 1. This means both the t-test and alpha value on Table 1 above indicated that the mean difference (0.34) between the two groups is not significant. Consequently, hypothesis one which states that, "there is no significant difference between the ecological knowledge of university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria" was retained.

Table 2: Descriptive statistic and t-test result of students' ecological critical thinking

Group	N	Mean	Standard Deviation	Mean Difference	t-value	P-Value
Experimental Group	105	11..87	1.61	2.59	12.26	0.00
Control Group	105	9.28	1.44			

Source: Field work (2022)

$\alpha = 0.05$

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Data on Table 2 above shows the descriptive statistics and t-test result of students' post-test scores from the section B of the EKTT which measured their ecological critical thinking. The results revealed that students in the experimental group who were trained using concept mapping instructional strategy have a score and standard deviation 11.87 and 1.61 respectively, while those students in the control group who received ecoliteracy training using lecture method of instruction have a mean score and standard deviation 9.28 and 1.44 respectively. The mean difference between the two groups is 2.59 in favor of students in the experimental group. This answered research question two which sought for the difference between ecological thinking among university students exposed to Concept mapping and those with the lecture method in Sokoto State, Nigeria. Furthermore, the analysis on the table shows that the p-value (0.00) is less than the alpha value (0.05) set for this research, and the t-value (12.26) is greater than the critical value (1.97) at 0.05 alpha value estimated by G-power calculator in Figure 1. This means both the t-test and alpha value on Table 2 indicated that the mean difference (2.59) between the two groups is significant. Consequently, hypothesis two which states that "there is no significant difference between the ecological critical thinking of university students exposed to Concept mapping and those with Conventional Method in Sokoto State, Nigeria" was rejected.

Table 3: Descriptive statistic and t-test result of concept mapping and gender on ecological knowledge

Group	N	Mean	Standard Deviation	Mean Difference	t-value	P-Value
Male	59	10.61	1.35	0.39	-1.36	0.17
Female	46	11.00	1.53			

Source: Field work (2022)

$\alpha = 0.05$

The summary of descriptive statistics and t-test results presented in Table 3 shows that male students trained using Concept Mapping have a mean score of 10.61 and standard deviation of 1.31, while female students trained using similar methods have a mean score 11.0 and standard deviation 1.53. The mean difference between the two groups (0.39) suggested that female students have a slightly better ecological knowledge than male students. Consequently, it provides an answer to research question 3 which sought for the difference between ecological knowledge of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria. Furthermore, the table shows that the p-value (0.17) is higher than the alpha value (0.05) set for this research, and the t-value (-1.36) is less than the critical value (1.97) at 0.05 alpha value estimated by G-power calculator in Figure 1. This means both the t-test and alpha value on the table indicated that the mean difference (0.39) between the two groups is not significant. Consequently, hypothesis three which states that, "there is no significant difference between ecological knowledge of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria" was retained.

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Table 4: Descriptive statistic and t-test result of concept mapping and gender on ecological thinking

Group	N	Mean	Standard Deviation	Mean Difference	t-value	P-Value
Male	59	11.76	1.68	0.24	-1.13	0.26
Female	46	12.00	1.51			

Source: *Field work (2022)*

$\alpha = 0.05$

The descriptive statistics and t-test result summary presented in Table 4 show that male students trained using Concept Mapping have a mean score of 11.68 and standard deviation of 1.68, while female students trained using similar methods have a mean score of 12.0 and a standard deviation of 1.51. The mean difference between the two groups (0.24) suggested that female students' ecological thinking is slightly better than that of male students. Consequently, it answered research question 4 which sought for the difference between ecological thinking of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria. Furthermore, the table shows that the p-value (0.26) is higher than alpha value (0.05) set for this research, and the t-value (-1.13) is less than the critical value (1.97) at 0.05 alpha value estimated by G-power calculator in Figure 1. This means both the t-test and alpha value on Table 4 indicated that the mean difference (0.24) between the two groups is not significant. Consequently, hypothesis four which states that, "there is no significant difference between ecological thinking of male and female university students when exposed to Concept mapping in Sokoto State, Nigeria" was retained.

DISCUSSION

This study investigated the effectiveness of concept mapping instructional strategy in enhancing university students' ecoliteracy and attitude. It compared the scores of students obtained from EKTT and EAI between experimental groups (trained using concept mapping) and control groups. The study had six major findings which were discussed as follows.

The first finding was made from the data in Table 1 which revealed there is no significant difference between the ecological knowledge of students in the experimental group and those in the control group. This was discovered when post-test scores of the section A of EKTT of the experimental group and control group were compared. This finding implies that both concept mapping and lecture methods improve student knowledge when used as an instructional method. The finding contradicts Akintola and Odewumi (2021), who investigated the effectiveness of concept maps on senior secondary school students' achievement in ecological concepts in Ogbomoso South, Nigeria. The finding of the study revealed that concept mapping improves students' ecological knowledge better than traditional lecture methods. The difference between the two studies is that the present study involves university students who are usually adult and educationally more mature compared to senior secondary school students used in the other study. Nevertheless, the two studies established that students'

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ecological knowledge is enhanced by method of instruction. This view can be supported by Harlinda and Reza (2019) who conducted a research which aimed to improve university students' ecoliteracy using problem solving methods; the study found that the method of instruction used improved students' ecological knowledge, understanding, awareness and application.

The second finding of the study was discovered when post-test scores from section B of the EKTT, which measures ecological critical thinking of students in the experimental group and control group, were compared. The independent t-test result summary in Table 2 shows that ecological critical thinking scores of students in the experimental group is significantly higher than that in the control group. The implication of this is that students who received ecoliteracy training using concept mapping instructional methods have higher critical thinking ability than those who received the same training using lecture method. Empirical evidence suggests that concept mapping instructional strategy can promote several thinking abilities such as critical thinking, reflective thinking, synthesis, analysis and eventually lead to higher order thinking ability (Cañas, Reiska, & Möllits (2017). This was supported by Aslami et al.7 (2021) who conducted a quasi-experimental study on 100 second-year medical students to find out the effectiveness of concept mapping on their critical thinking skills. The study found that medical students who were taught using concept mapping have significantly improved in critical thinking scores, compared with those in the lecture method group. Furthermore, Chen, Liang, Lee, and Chen (2011) investigated the effect of concept map teaching on students' critical thinking and approach to learning and studying. Results of the independent t-test and ANCOVA analyses revealed that students exposed to concept mapping have significantly higher scores than those exposed to traditional conventional methods. Thus, the study concluded that concept mapping is an effective tool for improving students' ability to think critically. In his Study, Ajaja (2011) reported that all the students interviewed in the concept mapping classroom agreed that concept maps helped them not only in the determination of the relationships among the concepts but also shaped their understanding of the concepts and increased their critical thinking.

The third finding of the study was revealed by data in Table 3 which shows that female students have higher mean scores than their male counterparts in the knowledge section of the EKTT. However, the independent sample t-test result in the table indicated that the difference between the two groups of students is not significant. This inferred that gender has no effect on student ecological knowledge when concept mapping is used during instructional delivery. The implication of this finding is that concept mapping is one of the instructional strategies which are gender friendly. Thus, in line with this, the finding was corroborated by Joel and Kamji (2016) who found no significant difference between the mean scores of male and female students taught using concept mapping strategy. Conversely, the finding contradicted Ogbonna (2014) and Egbo (2014) who in their separate research found that concept mapping has a significant effect on male and female students' knowledge. The difference between the two studies is that Ogbonna's reported that concept mapping instructional strategy favored male students, while Egbo's indicated female students scores higher than male students when taught using concept mapping. This study also compared critical thinking of male and female students in ecoliteracy with a view to finding the gender effect on critical thinking when students were taught using concept mapping. The analysis in Table 4 showed that female students have slightly higher mean than male students despite receiving the same treatment. However, the independent sample t-test result revealed that the difference between the two groups is not

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significant. Therefore, it is not sufficiently enough to suggest that concept mapping improves female students' critical thinking better than male students. Conversely, it indicated that concept mapping does not discriminate male and female critical thinking especially if it relates to ecoliteracy.

CONCLUSION

Determining the effectiveness of concept mapping in enhancing university students' ecoliteracy is the main target of this study, to enable them make valid decisions and take appropriate actions on ecological issues affecting their surroundings. The choice of concept mapping was as a result of its ability to allow learners to relate and connect concepts, ideas or issues for better understanding of their working. Substantial literature stresses the importance of concept mapping on students' knowledge development, critical thinking and attitude. Findings of this study revolve around the effectiveness of concept mapping on students' ecological knowledge and critical thinking. The study concludes that both concept mapping and the lecture method enhance students' ecological knowledge and can be used as delivery methods at ecoliteracy training aimed at promoting ecological knowledge. On the other hand, if the aim of the training is to promote ecological critical thinking, concept mapping is more appropriate than lecture methods and is gender friendly.

RECOMMENDATIONS

1. The use of both concept mapping and lecture method can be encouraged at ecoliteracy training, which focuses on promoting ecological knowledge.
2. Ecoliteracy training designed to promote ecological critical thinking should adopt concept mapping instructional strategy especially among university students.
3. Concept mapping can be in both male and female groups during ecoliteracy programmes; it does not favor or discriminate between each of the two.

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