

EFFECTS OF SPATIAL PROBLEM BASED LEARNING ON HIGHER ORDER THINKING SKILLS AMONG UNDERGRADUATES GEOGRAPHY STUDENTS IN NORTHWEST UNIVERSITIES, NIGERIA

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Abstract

This study investigated the Effects of spatial problem based learning on Higher order thinking skills among university undergraduate geography students in northwest Nigeria, particularly in Geographic Information System(GIS) concept. Two objectives, two research questions and two hypotheses were formulated to guide the study. The study employed quasi experimental design, specifically pretest posttest design. 300 level undergraduates Geography students from two (2) universities in North-west, Nigeria were used. Simple random sampling technique was used to select the two (2) universities comprising 191 students using balloting method. The instruments used were Geographic Information System Critical and Creative Thinking Skills Test (GCCTST) for both pre-test and posttest. The instrument was adopted and validated by experts however, pilot testing was conducted to determine the reliability of the instrument which was subjected to test-retest method and PPMC was used to compute the reliability index which yielded a reliability coefficient of 0.83 indicating high reliability. The findings revealed among others that there is a significance difference between experimental and control groups in favour of experimental group indicating that spatial problem based learning was effective teaching strategy for improving University undergraduate Geography students Higher order thinking skills in GIS.

Keywords: Spatial Problem based learning strategy, higher order thinking skills, Geographic information system

Introduction

Science is conceived as the source of knowledge and the foundation to modern day scientific and technological world. Tofi, Usman and Lakpini (2021) revealed that science is a body of organized knowledge and a process of inquiry plays a very key roles in the growth and development of a nation in areas such as transportation, communications among others. Usman (2018) revealed that science is a study of nature and natural phenomena in order to discover their principles and laws. It is because of the importance of science that the Federal Ministry of Education in its National Policy on Education (FGN, 2014) emphasized the teaching of science subjects to its citizenry. The process and product of science are acquired through education in a specialized area of education such as science education (Ezeh, 2013). Science therefore, is receiving much emphasis in education because of its significance and relevance to life and society. The major goals of science education is to develop scientifically literate individuals that are concerned with high competence for rational thoughts and actions and this literacy lead to the production of technological manpower (Anita, 2014). Subjects classified as science includes: Biology, Mathematic, Physics, Chemistry and Geography. This study is concerned with geography as science education subject in both secondary schools and tertiary institutions of Nigeria.

The words Geography according to Dikshit, (2018) originated from the Greek word *geographe*, “geo” meaning earth and “*graphie*” meaning the writing or description. As part of science, Geography is directly related to its applications in everyday life. Holt-Jensen (2018) sees Geography as a discipline that seeks to describe and interpret the earth as the universe of man. Geography thus, as a discipline thus, enables learners to understand, master and utilize the available resources in their environment, to carry out different economic activities such as agriculture, fishing, lumbering, beekeeping, mining activities and forestry (Onyango, 2019). Omar (2016) revealed that Geography is an interdisciplinary field that overlaps with various disciplines such as science, technology, humanities and applied sciences which depends mainly on a visual tool that is “map”. These visual maps can be obtained through Geographic information System (GIS) which is among the sub disciplines of geography.

Geographic information system (GIS) according to Murad, and Khashoggi (2020) refers to an information system that works toward processing geographical data; it is a computer system that captures, stores, integrates, manipulates, analyzes, and displays spatially referenced data. It is also used to standardize, store, analyze, and model data for novel output and display maps and reports output. Huang, Shih, and Yen, (2021) posited that the composition of Geographic information systems (GIS) includes applications like automated mapping and management of facilities and land information systems. GIS is commonly used to summarize various computer-based applications involving gathering, modifying, analyzing, and displaying geographic information with other linked services.

The teaching of Geographic information system (GIS) remains an essential component that can develops skills and techniques for collection, manipulation analysis, interpretation, evaluation and displays spatially referenced data among students (kang-tsung,2016; McEwen, 2017; Mukherjee, 2018; Murad, & Khashoggi, 2020;Huang, Shih, &Yen,2021; Jebur, 2021; Bedair, sayed, & Almetwaly,2022).The information obtained from Geographic information system (GIS) has much relevance on physical and human activities such as the land used, urban planning, change detection analysis, disparity in temperature and rainfall, disaster control, and many others (Jebur, 2021). However, despite the relevance of Geographic information system (GIS) on physical and human activities, a critical review have shown that the Geographic information system (GIS) concept is perceived to be difficult as majority of geography students are lacking the skills and techniques required for learning the concept resulting to low critical and creative thinking skills among geography student.

The problem of teaching and learning geography has been attributed to problem such as lack of instructional materials, inadequate laboratory for practical’s and inappropriate and ineffective teaching methods employed by science teachers among others. The use of inappropriate and ineffective teaching methods has been reported as most critical factor. Zaidi, Hammad; Awad, Qasem; and Al-Mahdi, (2017) revealed that majority of science teachers employed Lecture method which is based on memorizing the concept thus; the encyclopedic knowledge is much valued rather than the acquisition of skills. Supporting this, Kingdom-Aaron, Etokeren and Okwelle (2019) ascertained that the method of instruction employed by most science teachers is the Lecture method. Lecture method is a teachercentered, which is predominantly, used as teaching method in the teaching of science subjects whereby no chance will be given to learners in teaching and learning activities (Tofi, Usman and Lakpini, 2021).

Scholars have outlined the Strategies for teaching science subject including geography for instance thinking. Yani and Mulyadi, (2020) revealed that Discovery Learning, Experiential Learning, Meaningful Learning, Learning Cycle, among others can be used to developed Higher order thinking skills. Mu’affiah and Prasetyo, (2018) revealed discovery learning as one model that can be used to improve students ability of critical thinking and student learning outcomes with matrix comparison. While Silviariza, Sumarmi &

Handoyo (2020) recommend the use of spatial problem based learning. This study used spatial problem based learning and examined its effects on undergraduate university student's critical and creative thinking skills.

Spatial problem based learning (SPBL) was used in this study for teaching the experimental groups. Silviariza and Handoyo, (2020) revealed that Spatial problem based learning (SPBL) is a learning model that provides opportunities for students to be able to provide solutions to problems by studying them spatially and scientifically. Spatial problem based learning (SPBL) strategy is theoretically based on psychological theory proffered by Vygotsky, Jean Piaget and Jerome Bruner among others who propose that children actively construct knowledge in a social context (Conway, 1997 in Benson, 2015).

Spatial problem based learning (SPBL) model create an atmosphere of learning geography that is scientific, active, critical, creative, collaborative, and innovative in solving Geographic problems (Silviariza and Handoyo, (2020). Thus, the application of Spatial problem based learning (SPBL) in geography classes can familiarize students with higher order thinking skill (critical and creative thinking skills) to solve problems. This study investigates the Effects of spatial problem based learning on higher order thinking skills among university undergraduate geography students in northwest Nigeria.

Higher order thinking skills (critical and creative thinking) involves the process of applying, analyzing, synthesizing, and evaluating issue with view to provide solution. Higher order thinking skills can be developed by all cognitive learning models such as Discovery Learning, Problem Based Learning, Project Based Learning, among others (Yani and Mulyadi, 2020). Lombardi, (2022) posited that higher order thinking skills (HOTS) corresponds with Bloom's taxonomy, with comprehending and remembering or recalling facts reflecting lower-order cognitive thinking, while, applying, analyzing, synthesizing, and evaluating as higher-order thinking, referring to more intellectual abilities and skills.

However, the higher order thinking skills are lacking among geography students (Kinniburgh, 2017; Nofrion, 2018; Yani and Mulyadi, 2020; Duran and Mertol, 2021) revealed that majority of geography students are lacking higher order thinking skills, but with the use of innovative teaching strategy like spatial problem based learning students higher order thinking skills could be improved. Supporting this, Handoyo and Purwanto, (2017) revealed that through active participation critical and collaborative learning, to analyzing and applying concepts, theories, and facts that are indeed needed in Geography learning students high order thinking skills increases. Silviariza and Handoyo, (2020) revealed that giving students opportunity to provide solutions to problems by studying them spatially and scientifically increases their thinking skills (critical and creative thinking skills).

Gender refers to the socially culturally constructed characteristics and roles which are ascribed to males and females in society (Okeke, 2018). Some studies found male students performing on average, better than female counterpart; some found female performing better than their male counterpart while others found no significance difference (Nwanekezi, 2018). This study investigates the Effects of spatial problem based learning on higher order thinking skills among university undergraduate geography students in north-west Nigeria.

Statement of the Problem

The thinking skills of geography students' especially higher order thinking skills such as critical thinking skills, creative thinking is very low. On the various studies cited (Syaibana, Putra, Suharto, Rizal, Chia, Chun, & Opoku 2022; Duran V, and Mertol, 2021; Yani & Mulyadi, 2020; Ananda, & Nofrion; 2019;

Kinniburgh, 2017). It was observed that the problems of teaching and learning geography more especially at higher education level still persist with geography students having low thinking skills. Geographic information system (GIS) has been identified as concept perceived to be difficult by geography students, it requires student to develop skills for collection, manipulation analysis, interpretation, evaluation and displays of spatially referenced data (Kang-tsung, 2016; McEwen, 2017; Mukherjee, 2018; Murad, & Khashoggi, 2020; Huang, Shih, & Yen, 2021; Jebur, 2021; Bedair, Sayed, & Almetwaly, 2022).

A critical review has shown that the teaching and learning of geography particularly Geographic information system (GIS) is perceived to be difficult as majority of geography students are lacking the skills and techniques required for learning the concepts thus, resulting to low critical and creative thinking skills among geography students. Research report (Widana, 2017; Nofrion, 2018; Yani and Mulyadi, 2020) revealed that majority of geography students are lacking higher order thinking skills (critical and creative thinking) required for learning the concepts which enable students to synthesize, analyze and evaluate science concepts, thus, resulting to low critical and creative thinking skills. Low critical and creative thinking skills among university undergraduate geography students has been attributed to inappropriate and ineffective teaching method employed by science teachers. Zaidi et al (2017) revealed that majority of science teachers employed Lecture method which is based on memorizing the concept thus; the encyclopedic knowledge is much valued rather than the acquisition of skills.

However, many instructional approaches have been proffered by Psychologist like Bruner, Piaget, Gagne, and Vygotsky, for improved higher order thinking skills in science subject. Despite various innovations on the use of effective activity based teaching strategy, the problem of thinking skills of students still persists in geography at high institutions level. To reduce this drawback, the researcher tried to use spatial problem based learning and see its effectiveness toward improving the situation. The problem of the study therefore is to investigate how effective is spatial problem based learning in improving students higher order thinking skills of Geographic information system (GIS) in northwest universities Nigeria. Also would spatial problem based learning strategy have gender influence on the students and higher order thinking skills?

Objective of the Study

In specific terms, the objectives of the study based on critical and creative thinking skills are to;

1. Determine the mean critical and creative thinking scores of undergraduate university Students in geographic information system exposed to spatial problem based learning and conventional lecture method.
2. Investigate the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using concept mapping teaching strategy.

Research Questions

Based on the stated objectives the following research questions are raised:

1. What is the difference between the mean critical and creative thinking scores of undergraduate university Students in geographic information system exposed to spatial problem based learning and conventional lecture method?
2. What is the difference between the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using concept mapping teaching strategy?

Null Hypotheses

Based on the stated research questions the following null hypotheses were formulated to guide this study.

H₀₁: There is no significant difference in the mean critical and creative thinking scores of undergraduate university Students in geographic information system exposed to spatial problem based learning and convectional lecture method?

H₀₂: There is no significant difference in the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using concept mapping teaching strategy?

Methodology

This study employed quasi-experimental research design, specifically, pretest, posttest design. Intact classes were used to avoid disruption of normal lessons. During first week of the study, pre-test using Geographic Critical and Creative thinking Skills Test (GCCTST) was administered to both the experimental and the control groups to ascertain their performance at the beginning of the study so as to ensure equivalent, after which they were exposed to treatment for one semester and at the end of which post-test was administered using (GCCTST) to determine students' critical and creative thinking skills.

The population of the study comprised of 1837 geography students in northwest universities including 1354 males and 483 females. However, the sample sizes used in this study were two universities (2) selected as sample of the study through simple random sampling technique. The sampled universities were assigned experimental and control groups using simple random sampling technique. University E served as Experimental University and G served as Control. Geography study program class of 2022 session from each sampled schools was selected using random sampling technique. The two universities were assigned experimental groups and control with the following table;

Table 1 Showing Sample of the study

S/N Schools	Male	Female	Total
1. Experimental School	63	35	98
2. Control School	59	34	93
Total	122	69	191

Instrumentation

The instrument used in the study was Geographic critical and creative thinking skills Test (GCCTST) which was adapted from Ennis (2011). The instrument needed in this research is a critical and creative thinking skills test in the form of a test question sheet that refers to the indicators of critical and creative thinking skills. Test sheets were prepared to obtain learning outcomes data on critical and creative thinking

skills. Students are said to be able to think critically if they meet the indicators of critical and creative thinking skills

The validity of the instrument Geographic critical and creative thinking skills Test (GCCTST) was determined by experts and all observations and corrections made were incorporated into the final draft. A pilot test was conducted to establish the reliability of the instrument using test -retest method and finally subjected to person product moment correlation (PPMC) to ascertain internal consistency and reliability index ($r= 0.83$) was obtained indicating high reliability.

Results

The research questions raised were answered using descriptive statistic; (Mean and standard deviations), however the corresponding null hypotheses were analyzed using inferential statistic (z-test)

RQ1: What is the difference between the mean critical and creative thinking scores of undergraduate university Students in geographic information system exposed to spatial problem based learning and convectional lecture method?

Table 2. Showing mean and standard deviation between male and female in the experimental group

Groups	N	Mean	SD
Experimental	98	24.8	4.3
Control	93	16.12	3.89
Total	191		

Table 2 indicated that the mean difference between the Experimental and control groups is 8.68 while the experiment control group has a S.D of 4.3 controls has S.D of 3.89 indicating that their responses in the posttest are closely related. This indicates that there is difference the mean critical and creative thinking scores of Experimental and control groups in favour of experimental group

H01: There is no significance in the mean critical and creative thinking scores of undergraduate university Students in geographic information system exposed to spatial problem based learning and convectional lecture method.

Table 3. Z – test Analysis of posttest scores between the experimental and control group a

Group	N	Mean	S.D	df
Experimental	98	24.8	4.3	189

0.00	Ho1Rejected		
Control	93	16.12	3.94 Total
191			

$P \leq 0.05$ Table 3 revealed that the $P = 0.00$ at $P \leq 0.05$ indicating a significance difference between the two groups therefore null hypothesis is rejected. This signifies that experimental group exposed to spatial problem based learning has high critical and creative thinking skills.

RQ2: What is the difference between the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using spatial problem based learning strategy?

Table 4. Showing mean and standard deviation between male and female in the experimental group

Groups	N	Mean	SD	Std Error
Male	63	23.50	4.1	0.46
Female	35	23.27	3.87	0.25
Total	98			

$P \leq 0.05$

Table 4 showed that the mean difference between male and female Experimental groups is 0.23 while the male has an S.D of 4.1 and female has S.D of 3.87 indicating that their responses in the posttest are closely related. This shows that the difference between the critical and creative thinking of male and female geography Students is insignificance

Ho2: There is no significance mean difference in the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using spatial problem based learning

Table 5. Z – test Analysis of posttest scores between the experimental and control group

Group value	N Decision	Mean	S.D	df	P-
Male	63	23.50	4.1		
Female	35	23.27	3.87		
Total	98			96	

Table 5. Indicated that the observed p-value is 0.77 with df 96, since the observed p-value (0.77) is greater than the level of significance difference: 0.05, the null hypothesis is hereby retained. Therefore, there is no significant gender difference in mean critical and creative thinking skills of male and female undergraduate geography students.

Discussion of the Findings

The first findings also revealed significant difference between the mean critical and creative thinking scores of undergraduate university Students in geographic information system when taught using spatial problem based learning and those taught using conventional lecture method in favor of experimental group. The finding agreed with the earlier findings of Silviariza and Handoyo (2020), who revealed that spatial problem, based learning improved critical and creative thinking skills in geography. The finding also is in line with the finding of Umiyaroh and Handoyo, (2017), Farah, Handoyo and Bachri, (2018), who disclosed that problem based learning model Increases students' critical and creative thinking which is influenced by interactive learning and scientific learning processes.

The second findings disclosed significant difference between the mean critical and creative thinking scores of male and female undergraduate university Students in geographic information system when taught using spatial problem based learning in favour of male students. The finding is in line with the earlier findings of Madina and Ochonogor (2018) in their study investigate the Comparative effect of two problem-solving instructional strategies on students' achievement in chemistry and found that the performance of students in the experimental group was not influenced by gender.

Similarly, Osuafor and Orji, (2017) conducted a study on the Effect of problem solving technique on secondary school students' academic achievement in selected topics in algebra and disclosed that gender had no significant influence on performance in mathematics. this finding contrary to the findings of Itodo (2019) investigates the Effects of problem based learning strategy on secondary school students' interest, performance and retention in Biology in Taraba State, Nigeria and revealed that male and female students taught Biology in the experimental group equally benefited in performance from the problem based learning (PBL). On the contrary, Eyenaka, Uko and John (2016) revealed that female students benefited more from Problem Based Learning Techniques and discovery-base strategies than male counterpart. Therefore, from the above discussion, we can deduce that application of the Spatial Problem Based Learning (SPBL) model has more effects on critical and creative thinking skills than conventional methods.

Conclusion

Based on the findings of this research, it concluded that Spatial Problem Based Learning (SPBL) model enhances geography student's critical and creative thinking skills in geographic information system (GIS) among undergraduate university students under study.

Recommendations

Based on the findings the following recommendations were made.

1. Geography teachers in in university should emphasized, encourage and expose their students Spatial Problem Based Learning (SPBL) model as it was found to be effective teaching strategy for improving critical and creative thinking skills

2. The Government through Nigerian university commission (NUC) and other professional bodies should ensure that lecturers in the universities employ innovative teaching strategy such as Spatial Problem Based Learning (SPBL) model with other teaching techniques which could be possible through seminars and workshops as the strategy was found effective and gender friendly in this study.

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