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MEASURING CREATIVITY ON LONGITUDE AND LATITUDE USING VAN HIELE'S LEARNING MODEL AMONG SELECTED SENIOR SECONDARY SCHOOLS IN SOKOTO STATE, NIGERIA

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Abstract

This paper was aimed to measure the creativity which call for originality and uniqueness of ideas, concepts, techniques or skills that possibly lead to production and innovation. Little attention is paid to the uniqueness and originality of an idea but rather dominant on the recall, repetition and reproduction of ideas, concepts, techniques or skills. The research was guided by two research questions with equivalent null hypotheses. Quasi-experimental design entailing pretest and posttest was employed. This research's target population comprises all senior secondary school students (SSS 3) in the State. Two hundred sixty-seven students were selected using simple random sampling through balloting. A Mathematical Creativity Test (MCT) was employed to collect data. The instrument was validated by the experts and reliability index was found to be 0.72 after pilot testing. The data collected was sorted based on the dimension of creativity as stated by Torrance. The data was analyzed using independent sample t-test. The result indicated a significant difference in the mean creativity score in favor of the experimental group. While it further shows no gender disparity. The researchers recommended that Van Hiele learning model should be embedded in teaching mathematics concepts related to geometry such as longitude and latitude as well as trigonometry.

Keywords

Creativity,
van Hiele Model,
Longitude,
latitude

Introduction

The technological development and advancement of any country is achieved through innovative ideas. These technological innovations cannot be achieved without properly training a creative mind. Innovation is directly depends on creative skills (Ma, 2006). Creative thinking leads to economic growth, self-reliance and well developed technology (Eric, 2005). Mathematics is considered a discipline concerned with logical reasoning which help in developing a creative mind for successful learning and innovation in science, technology, engineering, and mathematics. Literature portrayed that there is no single accepted definition of the concept (creativity), although, some define creativity as originality, divergent and convergent thinking, innovation, and imaginative activity to

create something new (Bolden, Harries, & Newton, 2010.,Idris & Nor, 2010).

According to Oxford advance learners' dictionary, Creativity is the quality or ability to create or invent something. It may be the ability to come up with a new idea, techniques or invent a particular instrument. Creativity means development of something original, new and valuable, such thing can be an idea, concept, a scientific theory, tangible material, joke or musical composition. While according to psychologists' creativity deal with originality and functionality. Whatever someone develop should be totally new not in existence before and at least functionally measurable. Gabora (2013) stated that creativity is a trait that makes us change the present, panel beat the past and makes a meaningful decision about the future, to produce something that does not exist and makes a good change. She believes that creativity involves person, process, product and place, which is called 4Ps. Creativity in education vary from completely new ideas to new way of addressing problems, from creativity specifically for art to the idea of scientific breakthrough. Creativity combines intellectual abilities, knowledge, thinking style, personality, motivation and environment (Sternberg, 2006).

Longitude and latitude is one of the important topics in mathematics curriculum that help to develop creativity. The knowledge of longitude and latitude are of significant important and a pre-request to other areas of specialization for creative innovation (Yusha'u, Hassan and Babuga, 2018). For example, aviation industry makes extensive use of these concepts. GPS (Google Positioning System) is used to identify various locations in the universe. Nonetheless, the performance of students in this topic is quite poor due to the neglecting innovative approach by the teachers in Nigeria (Ibid).Many students failed to get the required marks on various longitude and latitude exams. WAEC Chief Examiner's 2016 – 2019 Report indicated that students have problems solving questions on longitude and latitude. He suggested that teachers should use more suitable teaching approach that may involve practical delivery. Many efforts were made ranging from various workshops, change in teaching method, seminars, and individual teacher's effort but all prove little or no improvement as the problem persist up to 2021. Therefore, it is paramount beneficial to measure a variable that have an effect on the students' learning outcomes. Longitude and latitude concepts require students to think creativity. By improving the students' creativity, their performance is increase. In the light of this, the researcher finds it necessary to assess and measure students' creativity using Van Hiele's learning models. To achieve this the following objectives were set to guide the researchers.

Objectives of the Study

The study sought to find out impact of Van Hiele's learning model on students' creativity in longitude and latitude concepts. In specific terms, this study addressed the following objectives.

i. Investigate the level of creativity of SSS of Sokoto State taught longitude and latitude using Van Hiele's model in Sokoto State.

ii. Examine the difference in the creativity level between male and female SSS taught longitude and latitude using Van Hiele's model in Sokoto State.

Research Questions

This research specifically addressed the following questions.

i. Is there any difference in the creativity level of SSS of Sokoto

State taught longitude and latitude using Van Hiele's model of instruction and those taught using traditional model in Sokoto state?

ii. Should there be difference in the creativity level between male and female SSS of Sokoto State taught longitude and latitude uising Van Hiele's Model of instruction in Sokoto state?

Null Hypotheses

The hypotheses were generated in a null form and tested at 0.05 level of statistical significance using appropriate statistical tools.

HO_1: There's no significant difference in the creativity level of SSS of Sokoto State taught longitude and latitude using Van Hiele's model of instruction and those taught using traditional model.

HO_2: There's no significant difference in the creativity level between male and female SSS of Sokoto State taught longitude and latitude using Van Hiele's Model of instruction

Literature Review

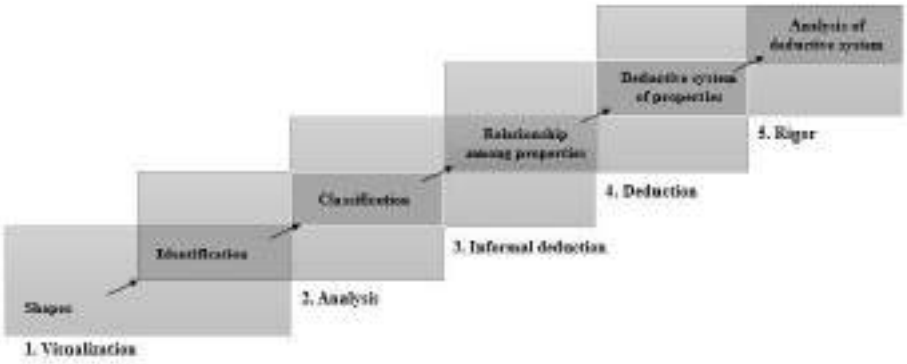
Many researchers have measured creativity on various aspect such as teaching method, teaching models, different locations, different research techniques and gender. Research conducted by Silvia, Wigert, Palmon & Kaufman (2012) posited the creativity of an individual varies even with self-report questionnaire. They further indicated that even in the higher institutions the creativity level of students changes with respect to their university. These changes may be due to the various teaching techniques or models employed by various institutions. While Pujawan, Suryawan and Prabawati (2020) investigated the effect of van Hiele's model of instruction on spatial ability of students. They posited that the intervention of Van Hiele's learning model improves students' spatial ability in plutonic solid. Their findings revealed that by employing Van Hiele's learning model, students' performance and thinking ability are improved. Furthermore, Yalley, Armah and Ansah (2021) studied the effect of van Hiele instructional model on students' achievement in Geometry. They posited that when Van Hiele learning model is employed the performance or achievement of students improve rigorously than when traditional method is employed. San and Lwin (2020) stated that using the Van Hiele learning model improves students' geometry performance and increases their willingness and readiness to learn geometry and other mathematical concepts. Erdogan, Akayya and Akayya (2009) believes that students creative thinking can be improve when Van Hiele's learning model is employed. According to Hassan, Abdullah and Isma'il (2020) after reviewing various research related to Van Hiele on various techniques such as technology intervention and various knowledge domain, they indicated the use of Van Hiele learning model whether blended with other techniques, styles or strategy or treated independently it improve students' geometric thinking.

Gender has become a concern to many researchers. This is because disparity in gender is wide in favor of the male sstudents. Many researchers posited that male students perform better than their female counterpart in science related subjects such as Mathematics, Physics, Chemistry and so on. Though with the evidence from previous researches some teaching methods and models are gender friendly such as research conducted by Altakhayneh (2020). He posited that the use of Van Hile's learning model can bridge gender disparity as both

male and female perform equally well. While Vojkuvkova & Haviger (2013) posited that when Van Hiele model is incorporated in teaching longitude and latitude the creative thinking and performance of male students tend to be better than their female colleagues. Furthermore, the research conducted by Erdogan (2006) on sex related differences in the acquisition of Van Hiele levels and motivation in learning geometry. He posited that no significant difference between male and female students.

Van Hiele's Model

After observing secondary school having difficulty in learning geometrical figures and problem associated to it. The Dutch educators Pierre Van Hiele and his wife Dina came up with a model to simplify the teaching and learning of geometry and other topics associated with geometrical figures. The model is presented hierarchically to simplify the concepts. The following diagram represents the levels based from level 1 – level 5, as modified from level 0 – level 4 (Van de Walle, 2001). Literature, indicated that students at secondary school can only achieved level 1 – 4.Thus, theory propose phases that can be used as instructional guide to achieve the levels of that includes inquiry/information; direct/guided orientation; explication/explanation; free orientation and integration (Hassan, 2021). The present research adopted the phases of van Hiele Model of instruction to develop students' creativity.



Level 1: Recognition or Visualization

At this level the learners are capable of identifying figure or picture by their appearance. They should be able to recognize various figures by their appearance. Such as identifying a circle, triangle, rectangle e t c. They should also be able to identify such pictures or figures in a real life and the things around our environments. In this context, the students should be able to identify the globe and lines of longitude and latitude and other features

Level 2: Analysis

At this level, students will begin to recognize the properties of a shape. Identify them by their various properties but without being able to make meaningful justification for their relationships. Students should be able to identify longitude and latitude when on the same globe.

Level 3: Informal Deduction (Ordering)

At this stage students logically order figures by their properties. Such ordering can be done through deduction and understanding the interrelationship between figures

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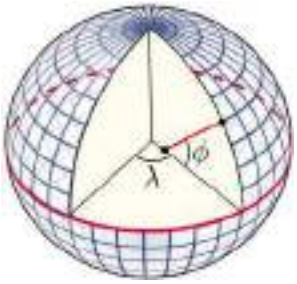

Level 4: Deduction

Students begin to apply logical thinking, connecting with various figures' properties. They make deductions, proofs and are able to understand axioms and theorems. At this level the students will begin to make rigorous calculations and proofs. Students will be able to calculate an angle formed by the longitude or a distance covered by an aero plane between two or more countries as well as time taken

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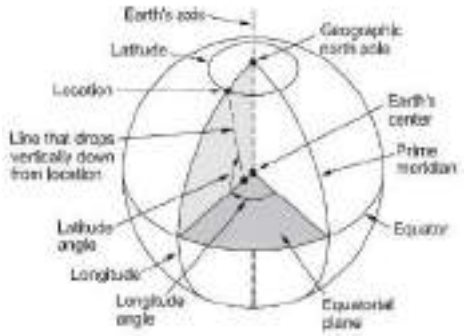

Torrance Test of Creative Thinking (TTCT)

Ellis Paul Torrance was an educationist born on 8th October, 1915. He was born to the family of Ellis and Jimmie Paul Torrance at Milledgeville in Georgia. He started his formal education in1923 at Union Point School. He won many awards in elementary, junior and higher school between 1928 to 1934. Torrance started teaching at Midway Vocational Higher School close to his hometown. In 1937 Torrance was offered a teaching position at his almamata Georgia Military College where he taught French, algebra and history. Later on Paul secured admission in the University of Minnesota where he studied counselling psychology at the Masters level. In 1948 Torrance return to University of Michigan as a doctorate student and graduated in 1951. In 1956 he published many articles on survival and stress reactions to emergent conditions and the importance of using creativity to overcome these conditions. In 1958 Torrance begins designing test of creative thinking, now known as Torrance Test of Creative Thinking. The test was divided into figural and verbal. In the figural form of creativity test the following factors sum up to identify a creative thinking.

i. **Fluency:** This indicates the number of relevance responses. It signify whether the answer captured a whole or part of the correct or expected responses. Mathematically this means responding to question with correct formula or method. The response may not be uniquely good but can be part of the expected relevance response.

ii. **Flexibility:** This seem closer to the above dimension because it also captured various categories of response or shift in response. This is also differ with fluency in the sense that flexibility required different approach, techniques or dimension to make a relevance expected response.

iii. **Originality:** This indicates the unusual response yet relevant and correct. The response may be common and unusual and highly imaginative. Originality signifies the uniqueness of the response and yet relevant and expected.

iv. **Elaboration:** This is ability for a participant to produce detail explanation of the answer. To explain the answer in detail and in creative way.

Resistance to premature closure: This indicate person's ability to keep open to weight different alternatives to be imaginative and delay closure long enough to form an original idea.

Methodology

The study was conducted in Sokoto State, Nigeria. The target population of this study are the entire Senior Secondary School Students three (SSS 3). There are 28,897 SSS 3 in the entire secondary schools in Sokoto State. 267 students were selected as estimated by Krejcie and Morgan (1970) table of sample size. These students are from two selected secondary schools. The secondary schools were selected through simple random sampling technique using balloting method. This study employed quasi experimental design entailing pretest and posttest. This design involves Experimental and Control Group (EG & CG). The two schools selected were assign as EG and CG. 125 students form the CG while 142 students fall under the EG. In the CG out of 125 students 72 are male and 53 are female. In the EG out of 142 students 83 are male and 59 are female. The EG were taught longitude and

latitude concept using Van Hiele's learning model for a period of four (4) weeks while the CG were exposed to traditional method without integrating Van Hiele's Model for a period of four (4) weeks. Mathematical Creativity Test (MCT) was used to collect data. The creativity test was design base on four factors of Torrance Creativity Test. The instrument consisted of three theory questions. The questions were designed to have multiple dimensional approaches to answer in more complex divergent thinking. The test was originally design with 6 questions. Through validation the questions were reduce to three. The reliability index of 0.72 was obtained through test-retest approach. The instrument was administered to the groups initially before treatment and at the end. The two research questions were answered using descriptive statistics. The first and second null hypotheses were analyzed using independent sample t-test.

Research Result

The data collected was analyzed using appropriate statistical tools. The analysis is presented below. In order to measure creativity a scoring guide was developed as shown below

Table 1: Creativity Scoring Guide

Creativity Factors	Description	Scoring
Fluency: The number of relevance responses	A non-relevance response	0
	Relevance response yet not correct	1
	Relevance but not unique	2
	Relevance and correct	3
	Relevance and unique	4
Flexibility: The number of different categories or shift in responses	None of the response fall within the	0
	At least one of the responses is accurate	1
	At least two of responses are accurate	2
	At least three responses are accurate	3
	More than three responses are accurate and logically presented	4
Originality: The number of unusual yet relevant ideas as determine by statistical infrequency	A response similar to everyone	0
	A response different from 20% of the other respondents	1
	A response different from 40% of the other respondents	2
	A responses that is uniquely above the 50% of the respondents	3
	An unusual yet relevant response above 80% of the respondents	4
Elaboration: the number of details used to extend a response.	Response with no detail explanation	0
	Response with a little explanation	1
	Response with explanation above the 40% of the respondents	2
	Response with explanation above the 50% of the respondents	3
	Response with detail explanation above the 80%of the respondents	4

Research Questions

The two research questions were answered using descriptive statistics as indicated in the tables below

Research Question 1: Is there any difference in the creativity level of SSS of Sokoto State taught longitude and latitude using Van Hiele's model and those taught using traditional model in Sokoto state?

Table 2: Mean Creativity of Experimental and Control Group

Group	N	Mean	Std Dev.	Std Error Mean
Experimental	142	2.72	1.34	0.11
Control	125	1.49	0.85	0.07

From the table above, students who were exposed to Van Hiele's learning model have a mean creativity gain of 2.72 while their counterpart has only 1.49. The mean difference here is 1.23 in favor of the experimental group.

i. Research Question 2: Should there be difference in the creativity level between male and female SSS of Sokoto State taught longitude and latitude using Van Hiele's Model of instruction in Sokoto state?

Table 3: Mean Creativity of Male and Female in the Experimental Group

Gender	N	Mean	Std Dev.	Std Error Mean
Male	83	2.57	1.30	0.14
Female	59	2.95	1.37	0.18

From the table above, the mean creativity gain of female students is 2.95 above male students by 0.38.

Analysis of Null Hypotheses

The two null hypotheses were tested using independent sample t-test at 0.05 level of statistical significance.

HO_1: There's no significant difference in the creativity level of SSS of Sokoto State taught longitude and latitude using Van Hiele's model of instruction and those taught using traditional model

.**Table 4: Analysis of Creativity in Experimental and Control Group**

Group	N	Mean	Std Dev.	P-value	Decision
Experimental	142	2.72	1.34		
				0.001	Rejected
Control	125	1.49	0.85		

Decision Criterion: Reject H_o if P≤0.05

Based on the decision criterion, this null hypothesis is rejected from the above table. This indicated a significant difference between students exposed to longitude and latitude using Van Hiele's learning model and those exposed to traditional methods.

HO_2: There's no significant difference in the creativity level between male and female SSS of Sokoto State taught longitude and latitude using Van Hiele's Model of instruction

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Table 5: Analysis of Creativity of Male and Female in the Experimental Group

Gender	N	Mean	Std Dev.	P-Value	Decision
Male	83	2.57	1.30		
				0.074	Accepted
Female	59	2.95	1.37		

Decision Criterion: Reject H_0 if P≤0.05

Table 5 indicated no significant difference in mean creativity of male and female students when taught longitude and latitude concepts using Van Hiele's learning model. This shows that the model can bridge gender disparity.

Discussion

The finding of this research from first research question indicated that students exposed to teaching longitude and latitude using Van Hiele's learning model improve their creative thinking. These findings re-confirm the results Erdogan, Akayya and Akayya (2009) obtained. Their findings indicated that students who were taught geometry using Van Hiele's instruction model improve their creative thinking more than those taught using traditional approach. The findings re-validate the results submitted by San and Lwin (2020) who use the mixed method research to investigate students' performance, readiness and willingness to learn geometry through Van Hiele's learning model. They posited that student's performance improve when taught using Van Hiele's learning model. Similarly, the findings confirm to the findings of Yalley, Armah and Ansah (2021).

The research revealed no significant difference between male and female students. The difference is meager to a negligible size. This finding confirms the result of Erdogan (2006). His findings revealed no effect of Van Hiele learning model on gender. So also the finding of Altakhayneh (2020) attest to this finding that Van Hiele learning model bridge gender disparity. But this finding is contrary to result submitted by Vojkuvkova & Haviger (2013).

Conclusion

Based on the findings of this research, it was concluded that using Van Hiele's learning model increases performance, creative thinking and even willingness and readiness of the students to learn Mathematics. But the findings indicate female students can perform as much as their male counterparts. This does not indicate that female students perform better than male students in all creativity. After all male students gain more scores in originality aspect of creativity.

Recommendations

Based on the findings of this research, the following recommendations were made

1. Teaching Mathematics should be made to develop creative thinking instead of building on the recall of fact and plugins the variable in the formula.
2. Van Hiele's learning model should be embraced in teaching aspects of Mathematics related to geometry such as longitude and latitude, trigonometry rather than traditional teaching method.
3. Workshops and seminars should be organised by the government and professional organizations such as MAN and STAN to equip teachers with knowledge of Van Hiele's learning model.
4. The model has the advantage of being gender friendly and, therefore should be encouraged in teaching longitude and latitude

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