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Comparison of Inquiry, Demonstration and Concept Mapping Teaching Methods Influence on Student's Academic Performance in Thermal Physics Among Senior Secondary School Students in Kebbi State

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Abstract

The study is a comparison between the influence of inquiry, demonstration and concept mapping teaching methods on academic performance in thermal physics. The research design was quasi factorial design, which is concerned with interactive effect of two or more independent variables in any combination on dependent variable. The study was guided by three objectives, research questions and hypotheses. The population of the study was 912 Senior Secondary Two (SS 2) students out of which a sample of 241 was selected from six intact classes of six Senior Secondary schools. The instrument used for data collection was Thermal Physics Performance Test (TPPT) of 30 items multiple choice questions. The instrument was validated by three physics teachers and its reliability was established after pilot study using Cronbach's - Alpha formula, which produced a reliability coefficient of 0.8. The students were taught thermal physics for six weeks and the instrument was administered. The data collected was analyzed using descriptive statistics and t- test at 0.05 level of significance. At the end of the analysis, it revealed that students taught thermal physics using inquiry teaching method performed higher than those taught using demonstration and concept mapping teaching methods and those taught using demonstration method performed higher than those taught using concept mapping strategy. Based on these findings it was recommended that physics teachers should embraced the use of inquiry teaching method for better students' performance.

Keywords: *Inquiry, Demonstration, Concept Mapping, Academic performance*

1. Introduction

Write Teaching and learning of science required the application of suitable methods which promote understanding of concepts, principles and laws of science Physics in Nigeria is one of the science subjects

taught at senior secondary level and beyond. The nature of the subject in terms of abstract and mathematical contents make students at this level uncomfortable which influence their unfavorable attitude and interest in the subject (Aliyu, 2021)

Teaching method is a process of facilitating learners through proper management by the teacher coupled with cordial relationship between the teacher and students (Ebenezer, 2016). The teacher in theses interactions is considered as the supplier of the knowledge of the subject matter while the students are at the receiving end. Different teaching methods exist and the application of any method depends on different factors, including nature of the subject. These methods were classified as students centered approach, teacher students' interactive approach and teacher centered approach but the essence of any teaching approach is to produce higher level comprehension of the subject matter.

Inquiry teaching method is a students' centered approach which involves teaching to get knowledge of "how" not "about" (Abubakar, 2018). It is a process rather than contents orientation, experimental rather than factual emphasis (Shangavelu & Edma, 2020). The method guides the students to answer the questions in investigation the problem and arriving at the desired knowledge of the subject matter with minimum or no teacher interference. In this teaching method, teacher acts as a guide in an effort to find truth that require thinking critically, making observations, asking questions designing of experiment and drawing conclusions (Adjei & Wison, 2020). On the other hand, demonstration teaching method is a teacher student interactive teaching strategy; it involves practical display or exhibition process and services to show or point out the fundamental principles involved in the subject matter (Musa, 2019). In this method the teacher is the principal actor while the students watch or act later (Aktamis, 2020). In this teaching strategy, the teacher seeks for subject matter to be taught from various sources, process it and explains the concept of the subject matter and demonstrate using the provided instructional materials. This demonstration can be done by the teacher students or both. Concept Mapping is a teaching strategy in which the idea that contains two or more concepts are connected with other words to form a meaningful statement represented diagrammatically (Evrowoke, 2017). It is a teaching method which emphasizes presenting hierarchically, the existing relationship among various concepts. It characteristics are the hierarchical nature which arranged more general concepts at the top of the structure and the specific concepts below (Kusma, 2020).

The role of teaching method is to enhance smooth transmission of knowledge to the learners which ultimately lead to better understanding with good academic performance at the end of evaluation. Academic performance is the scholastic outstanding of students at a given moment (Sintyehu, 2024). This outstanding scholastic is in terms of the grade obtained in a course or group courses. In fact, it is the learning outcomes of the students at the end of instructional period.

Thermal physics is a branch of physics which is concerned with the study of heat and temperature. Its contents comprises of concept of temperature, heat energy, latent heat, specific latent heat and heat capacity gas laws and expansivity among others. The focus of this study is to compare the influence of inquiry, demonstration and concept mapping teaching methods on the students' academic performance in thermal physics among senior secondary schools students in Kebbi State.

STATEMENT OF THE PROBLEM

Several studies support the general view that the poor performance of students in examinations emanated from the inappropriate teaching methods adopted by the classroom teachers. This poor performance had also been observed in physics in Kebbi State. The results collated from Senior Secondary School WAEC/SSCE from 2020 – 2024 in physics revealed that only 38.75% of the candidates who sat for subject were able to get credit level that may enable them secure admission in physics related courses in the tertiary level of

education. Researchers such as Aliyu (2021), Jena, (2021) and Okagbare, Ossai and Osedbe, (2023) attributed it to the inappropriate teaching methods adopted by physics teachers in teaching the subject. The researchers pointed out that most physics teachers resort to adopting traditional method of teaching which is unsuitable for the subject. It is against this background that this study is conducted to ascertain the influence of other methods such as inquiry, demonstration and concept mapping teaching methods on the academic performance of students in thermal physics in Senior Secondary Schools in Kebbi State.

OBJECTIVES OF THE STUDY

The objectives of the study are to:

(i) Find out if there is any significant difference in academic performance between students taught thermal physics using inquiry teaching methods and those taught Using demonstration teaching method.

(ii) Find out if there is any significant difference in academic performance between students taught thermal physics using inquiry teaching methods and those taught Using concept mapping teaching method.

(iii) Find out if there is any significant difference in academic performance between students taught thermal physics using demonstration teaching methods and those taught Using concept mapping teaching method.

RESEARCH QUESTIOONS

These research questions for this study are:

(i).What is the difference in academic performance between students taught thermal physics using inquiry teaching method and those taught using demonstration teaching method?

(ii). What is the difference in academic performance between students taught thermal physics using inquiry teaching methods and those taught using concept mapping teaching method?

(iii). What is the difference in academic performance between students taught thermal physics demonstration teaching method and those taught using concept mapping teaching method?

NULL HYPOTHESES

The hypotheses were stated as follows:

(i), There is no significant difference in academic performance between students taught thermal physics using inquiry teaching method and those taught using demonstration teaching method in Senior Secondary Schools in Kebbi State

(ii), There is no significant difference in academic performance between students taught thermal physics using inquiry teaching method and those taught using concept mapping teaching method in Senior Secondary Schools in Kebbi State

(iii), There is no significant difference in academic performance between students taught thermal physics using demonstration teaching method and those taught using concept mapping teaching method in senior secondary Schools in Kebbi State

REVIEW OF RELATED LITERATURE

Research studies have established the effect of teaching methods on the academic performance of the learners. Such findings were reported by Asmau (2023), Jepketina, {2017), Christine, Bilal, and Jerrin, (2019). On the influence of inquiry teaching method many research findings have revealed its effectiveness on the academic performance. Jakalon and Castillo, (2024) examined the effects of inquiry teaching method,

using pre-test post-test true experimental research design in comparison with lecture method. The finding revealed that students exposed to inquiry teaching method performed better than those exposed to lecture method. Similarly, Ekponyoung and Jeseph, (2020) examined inquiry learning approach and students' academic performance in physics using pre-test post-test experimental design. The experimental group was taught using inquiry method and the control group was taught using conventional method. At the end of the analysis it revealed that those taught using inquiry method performed better than those exposed to conventional method. On the influence demonstration teaching method on the academic performance of students Aluko and Odubun, (2020) studied the effect of demonstration teaching method in Elasticity in selected Federal Schools in Lagos. The design was pre-test, post- test experimental design which involves a sample of 78 students. The data was collected using Physics Students Achievement Test and was analyzed using descriptive statistics. The results showed that demonstration teaching method was better than lecture method. Moreover, Lukman and Haliru, (2022) compared the effect of demonstration and lecture teaching methods in Kebbi State A group of 24 each were treated with demonstration and lecture method respectively. At the end of the analysis using descriptive statistic, it revealed that the group exposed to demonstration teaching method performed higher than those exposed to lecture teaching method. Concept mapping as teaching strategy was also found to be effective in comparison with conventional teaching methods. To this end, Danjuma and Bajun, (2017) assessed the effect of concept mapping teaching method and competitive instructional strategies on students' performance in thermal energy in Taraba State. The design was quasi pre-test, post- test experimental design. Using Thermal Energy Performance Test, the data was collected and analyzed using Mean Standard Deviation and t-test. The result of the analysis revealed that students taught thermal energy using concept mapping have better performance than those taught using lecture method. Similarly, Awodin, (2017) studied the effect of concept mapping on students' academic performance in thermal energy in Senior Secondary Schools physics students in Ekiti State with a sample of 98 randomly selected students. The design was Quasi pre-test, test research design. The data was collected using Thermal Physics Performance Test and was analyzed using t test and the result of the study found that the overall mean of concept mapping performance was higher than that of the traditional method.

From the above review it could be understood that teaching methods have great influences on the academic performance but the extent at which a method can influence the performance varies with the nature of the method.

2. METHODOLOGY

The design was quasi- factorial design and the population of the study was 912 Senior Secondary Two students in six selected public Secondary Schools. The sample of study was 241 students in six intact classes of the six selected schools and the instrument used for data collection was Thermal Physics Performance Test (TPPT). The instrument was adopted from previous WAEC, NECO and NABTEB SSCE examinations, which consists of 30 items multiple choice questions. The instrument was validated by experienced physics teachers. The reliability of the instrument was established after pilot study, using Kuder- Richdson's Reliability (K-12) formula and reliability index found to be 0.83. Thermal Physics was taught for six weeks after which the instrument was administered. The questions were analyzed using Mean and Standard Deviation and the null hypotheses using t- test at 0.05 level of significance.

3. RESULTS

The results are as follows the sequence of the research questions and the hypotheses.

Research Question One

What is the mean difference in academic performance between the students taught thermal physics using Inquiry teaching methods and those taught using demonstration method in Kebbi State Senior Secondary Schools?

The results of the analysis are presented in table 1.

Table 1: **Mean analysis of difference between students taught thermal physics using inquiry teaching method and those taught using demonstration method**

Method	N	Mean	SD	Mean difference
Inquiry	81	42.65	9.36	6.48
Demonstration	87	36.17	10.31	

.Table 2 shows the mean difference between students taught thermal physics using inquiry and demonstration teaching methods. The difference between the mean is 6.48

Research question Two

What is the mean difference in academic performance between students taught thermal physics using inquiry teaching method and those taught using concept mapping in Senior Secondary Schools in Kebbi State?

Table 2: **Mean analysis of difference between students taught thermal physics using inquiry teaching method and those taught using concept mapping method**

Method	N	Mean	SD	Mean difference
Inquiry	81	42.65	9.36	3.10
Concept Mapping	75	33.7	11.3	

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Table 2 shows the mean difference between students taught thermal physics using inquiry and concept mapping teaching methods. The difference between the mean is 3.10

Research question three:

What is the mean difference in academic performance between students taught thermal physics using demonstration teaching method and those taught using concept mapping in Senior Secondary Schools in Kebbi State?

Table 3 shows the mean difference between students taught thermal physics sing inquiry and demonstration teaching methods. The difference between the mean is 6.48

Table 3: **Mean analysis of difference between students taught thermal physics using Demonstration teaching method and taught using concept mapping method**

Method	N	Mean	SD	Mean difference
Demonstration	87	36.17	10.31	3.10
Concept Mapping	75	33.07	11.31	

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Table 3 shows the mean difference between students taught thermal physics using demonstration and concept mapping teaching methods. The difference between the mean is 3.10

Testing Null hypotheses

HO_1: There is no significant difference in academic performance between students taught thermal physics using inquiry teaching methods and those taught using demonstratio44n method in Senior Secondary Schools in Kebbi State.

Table 4 T-test analysis for the difference in performance between students taught thermal physics using inquiry teaching method and those taught using demonstration method**.**

Variables	X	Mean	SD	Df	t value	P value	Decision
Inquiry	81	42.65	9.36	166	9.46	0.001	Rejected
Demonstration	87	36.17	10.31				

The table shows that calculated t value as 9.46 and the p- value is 0.001. Since 0.001 < 9.46 at 0.05 level of significance, the hypothesis is rejected hence concludes that there is significant difference in academic performance between students taught thermal using inquiry teaching method and those taught using demonstration method.

HO_2: There is no significant difference in academic performance between students taught thermal physics using inquiry teaching methods and those taught using concept mapping method in Senior Secondary Schools in Kebbi State.

Table 5 T-test analyses for the difference in performance between students taught thermal using inquiry teaching method and those taught using concept mapping method.

Variables	X	Mean	SD	Df	t value	P value	Decision
Inquiry	81	42.65	9.36	160	0.68	0.001	Rejected
Concept mapping	75	31.07					

i. The table 5 shows that calculated t value as 0.68 and the p- value is 0.0001. Since 0.001 < 0.68 at 0.05 level of significance the hypothesis is rejected hence conclude that there significant difference in academic performance between students taught thermal using inquiry teaching method and those taught using concept mapping method.

HO3: There is no significant difference in academic performance between students taught thermal physics using demonstration teaching methods and those taught using concept mapping method in Senior Secondary Schools in Kebbi State.

Table 6 t-test analyses for the difference in performance between students taught thermal physics using demonstration teaching method and those taught using concept mapping method.

Variables	X	Mean	SD	Df	t value	P value	Decision
Demonstration	81	42.65	9.36	160	0.68	0.001	Rejected
Concept mapping	75	31.07					

The table shows that calculated t value as 9.36and the p- value as 0.001. Since 0.001 < 0.68 at 0.05 level of significance the hypothesis is rejected hence conclude that there significant difference in academic performance between students taught thermal using inquiry teaching method and those taught using concept mapping method.

4. Discussions

The study investigated the influence of inquiry, Demonstration and concept mapping teaching method on academic performance in thermal physics among Senior Secondary Schools students in Kebbi State. The findings in table 4 revealed a significant difference in academic performance between inquiry and demonstration method as p = (001) < t (9.36). This has been in agreement with Ekumuye (2019) and Ekpenyoung and Joseph, (2019) as reported in the literature review. In addition to these, Azowamadu, Adeyemo and Babajide (2019) studied the effect of concept mapping and Atiko, (2025) on the effective approach in teaching thermal physics.

Table 5 revealed a significant difference in performance between inquiry and concept mapping teaching methods in that p (001) < t (0.36) at 0.05 level of significant. This finding has tallied with Aluko and Obubutu (2020) and Lukman and Haliru, (2025) as reported in the review of relate literature. Moreover, Zubairu, Gambari, Daramola and Folake, stuied the effect of inquiry and concept mapping in physics. A

Table 6 revealed a significant difference between students taught thermal physics using demonstration and concept mapping teaching methods. This finding has been in support of other findings as reported in the

literature review, such as Danjuma and Bajun, (2017) and Awodin, (2017). Moreover, Arokoya and Obunwa (2015) who studied the effect of comcept mapping in comparison with conventional method when those taught using cocept mapping performed better. This result has also been in agreement with Okardi and Tuesday, (2022), who found that students treated with concept mapping performed better than traditional method.

5. CONCLSIONS AND RECCOMENDATIONS

Based on the findings of this research study led to the following conclusions

1 Inquiry teaching method is more effective than demonstration teaching methods

2. Inquiry teaching method is more effective .than concept mapping teaching method

3 Demonstration teaching method is more effective than concept mapping

RECOMMENDATIONS

Based on these findings, the following recommendations are put forward.

1 Physics teachers should embrace the use of inquiry teaching method as a means of training student scientific method of obtaining knowledge

2 Where inquiry method is not possible due to some factors, demonstration method should be adopted and to ensure the students participation.

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Declaration of Conflicting Interests

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