



EFFECTIVENESS OF GUIDED INQUIRY IN COLLABORATION AND PROBLEM BASED LEARNING ON ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL CHEMISTRY STUDENTS IN MAIDUGURI METROPOLIS, BORNO STATE, NIGERIA

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Abstract

The study focused on the effectiveness of Guided Inquiry in Collaboration and Problem Based Learning on Academic Performance of Senior Secondary School Chemistry Students in Maiduguri Metropolis, Borno State, Nigeria. A population of 2344 was used for the study. one research question was raised and answered in the study using mean and standard deviation, while one hypothesis formulated was tested using ANCOVA at 0.05 level of significance. The instrument for data collection was chemistry performance test (CPT). Students of both groups were given pre-test to find out the performance of students before application of treatment. During the treatment the same test was given to the same groups of students at school with a given interval of 4 weeks and thereafter a post-test was given to the same students after treatment to measure the performance and compare the effectiveness of guided inquiry in Collaboration and Problem Based Learning. The findings of the study revealed that guided inquiry significantly scored higher in post-test than the pre-test. This is revealed in $(F(1, 11) = 7.404, p < .01, \eta^2 = .537) = 0.05$. Post-hoc tests revealed a substantial mean difference $(M = -34.090, SE = 0.281, p < .001) = 0.05$. The results revealed that there was no significant effect of guided inquiry in Collaboration and Problem Based Learning. Therefore, it was recommended that chemistry teachers should used guided inquiry teaching in chemistry classrooms.

Keywords: Learning Academic Performance, Chemistry Students, Collaboration, Comparative

Effectiveness, Guided Inquiry, Problem Based, Senior Secondary Schools.

Introduction

Guided inquiry is a learning process that engages students by making real-world connections through exploration and high-level questioning. The guided inquiry method is driven by one's own



curiosity, interest or passion to understand an observation or to solve a problem. Guided inquiry-based learning gives students the ability to question and interact with their educational material and the process they go through as they discover facts and details through their own efforts. It helps to instill a love of learning and an excitement for new opportunities. Trianto (2007) stated that, the guided inquiry method does not only develop intellectual abilities but including the emotional and skills development. Guided inquiry method has its root in the scientific ways of investigating issues in a structured arrangement. When it is related to learning, the strategy is a model for processing information that enables learners to discover relevance to give information following laid-down steps that enable them to conclude or reflect a newly attained set of knowledge. Effectiveness of guided inquiry methods gives students the ability to question and interact with their educational material and the process they go through as they discover facts and details through their own efforts, it helps to instill a love of learning and an excitement for new opportunities. There are five (5) steps to be taken in carrying out the guided inquiry model which include: (i) the formulation of the problem being solved by students (ii) set a temporary answer (hypothesis) (iii) students seek information to answer the problem (iv) draw conclusions or generalizations of the answer and (v) the conclusions or generalizations apply in new situations.

According to *Frontiers in Psychology* (2025), Collaborative learning refers to educational approaches where students work together in small groups to achieve shared learning goals. Collaborative learning is an educational approach involving joint intellectual effort by team members who engage in activities together, often in small groups. This method is based on the idea that learning is a naturally social act in which participants talk among themselves. It leverages individuals' diverse skills and perspectives to enhance the learning experience, fostering critical thinking, problem-solving, and learning retention through active engagement and interaction. Collaborative learning can occur peer-to-peer or in larger groups. Peer learning, or peer instruction, is a type of collaborative learning that involves students working in pairs or small groups to discuss



concepts or find solutions to problems. Similar to the idea that two or three heads are better than one, educational researchers have found that through peer instruction, students teach each other by addressing misunderstandings and clarifying misconceptions.

Ali (2019) stated that, Problem-based learning (PBL) is a student-centered approach that teachers use to promote students' critical thinking skills to solve real-life problems in a group discussion. Problem based learning can promote students' development of critical thinking skills, problem-solving abilities, and communication skills. It can also allow students to work in groups, find and evaluate research materials, solve problems, and engage in life-long learning. Teachers can use Problem based learning in any learning situation with a little creativity.

Until now there has been no apparent reference for implementing collaborative and problem-based learning, especially learning materials that are taught by teachers are the material needed by the students when they work. In the workforce, not all work can be done independently, but must be done through the teamwork. Knowing the importance of collaboration skills, teachers should begin to accustom their students to promote a collaboration skill among them self. However, unfortunately until now there has not been a clear reference for implementing collaborative problembased learning especially at the classroom. Based on several reasons as described above, there are two questions as follows:

- (1) how can collaboration and problem-based learning develop students' ability to do the problemsolving?
- (2) how can collaboration and problem-based learning develop students' ability to be skilled at work, both individually and in teams. Therefore, to answer these questions, it is necessary to implement Collaborative and Problem-Based Learning in our classroom.

Scott (2014) stated that, with the focus of the problem in the learning process, students can begin to deal with authentic and unstructured problems. Focused problems emphasize to the students' ability to connect the knowledge they have with their experience in solving problems. In



the learning process, this learning model requires students to form groups of 5-8 to maximize the diversity and experience of each. Students are required to be able to develop their abilities, both individually and help each other in groups. Students are required to be able to monitor or reflect on their understanding. They also need to be able to adjust learning strategies that are match with their characteristics. The teacher only acts as a facilitator who is no longer a disseminator of knowledge, but change as a student's facilitator. According to Ahamad (2017), teacher who organizes and develops a well- designed collaborative problem-based learning topic will provide students with the opportunity to develop their skills which will strongly assist them to cooperate as a team to solve a problem.

Hamilton (2025), stated that, the students face challenges with "the requirement of reliable internet access and devices, and the need for digital literacy" in digital collaborative and problembased learning environments. Traditional didactic learning remains the most common approach to medical education, where instructors acquire and deliver structured content to relatively large groups of students" while collaborative and problem-based learning requires students to become active participants, creating significant adjustment challenges. Tefera (2021) stated that, recent research indicates that "class success depends heavily on active student participation and attentive faculty. Unprepared or engaged students can hinder the learning experience for the entire class." Additionally, "instructors must be able to encourage discussion and also ensure that each student has the opportunity to participate. "Some specific points raised include lack of materials, negative student perceptions of collaborative problem-based learning, absence of standardized cases, and subjective assessments. "Problems encountered in educational practice usually stem from poor implementation of collaborative problem-based learning. In many cases the way in which collaborative problem-based learning is implemented is not consistent with the current insights on learning.



Collaborative and problem-based learning classes often utilize small groups to enhance active learning. However, these small groups also require more instructors than larger classes. Therefore, small group problem-based learning classes can increase administrative expenses for faculty and infrastructure including classrooms and technologies needed to cases and online platforms. “In other to implement a collaborative problem-based learning process in the classroom there must be some challenges and teachers must work to overcome these to make sure that students get the most of the problems they work on. Students may not have prepared for problem-based learning in their past studies, they may need some hand-holding and guidance if they’ve never worked on a real-world problem before.

Collaborative problem-based learning can be time-consuming and requires a significant amount of prep for teachers. Since students work in groups, there may be group dynamic issues to address and teachers must keep an eye on students. Collaborative and problem-based learning requires buy-in and support from staff and educational leaders. Teachers and administrators should work together before the collaborative and problem-based learning process is implemented to brainstorm ideas and identify potential issues.

Chemistry is one of the subjects that is offered in the Nigerian secondary school curriculum, whose objectives is to provide students with basic knowledge in chemical concepts and principles, through efficient selection of content and sequencing. According to Ayuba (2014) academic performance of Chemistry students is progressively becoming unscientific in their thoughts and approaches to problem-solving. Among the reasons for these problems are teachers' inability to put Chemistry ideas to students and the wrong perception of students that Chemistry is complex and tough. Some problems include, low enrolment and poor performance of secondary school students in West African Senior School Certificate Examinations. Chemistry, the branch of science that deals with the study of the composition and properties of matter, changes in matter, the laws and the principles that govern these changes has been characterized as the most utilitarian of all the



experimental sciences and is one of the subjects that is offered in the Nigerian secondary school curriculum.

Students perceive the subject as difficult and uninteresting and thus are biased in the selections they make, often not considering the subject requirements needed for future careers. According to West African Examinations Council (2017) Chief Examiners Report, some of the problems include low enrollment and poor performance of secondary school students in Nigeria.

Adamu (2021) stated that, poor teaching method is the genesis of students' poor academic performance in science. A wait time of 3-5 seconds should be allowed for students to respond to a particular question or problem, because it is a necessary skill required by teachers of science education in developing effective teaching and learning in classrooms.

According to Baba (2022), Wait-time is when a teacher waits after a question is asked before calling on a student to rephrase a question or supply the answer. It is the length of pause preceding any teacher's utterance. Even when the teacher has mastered the skills of controlling the pauses and is teaching a highly receptive class, the teacher's lesson may result in little or no learning if he or she fails to use wait-time properly. Selecting appropriate methods of teaching has become one of the shortcomings affecting learning and higher achievement in Chemistry. Many students find Chemistry to be a hindrance in attaining their aims and objectives. It is therefore necessary to properly groom the students right from the secondary school level to enable them improve their academic achievement in Chemistry. Poor performance of students in science subjects, particularly Chemistry, has assumed a serious dimension as reported by some parents. Therefore, teachers must find the most suitable methods to teach the students in order to determine best practices for classroom delivery and minimize achievement loss, using resources available to them. This motivated the researcher to undertake this study.



Statement of the Problem

Chemistry is one of the subjects that is offered in Nigerian Secondary School curriculum, whose objective are to provide students with basic knowledge in chemical concepts and principles, through efficient selection of content and sequencing. As a student of the Faculty of Education and teacher, the researcher has observed that, students' performance in schools especially in internal and external examinations, the academic performance is very low. These made parents to worry and express their concern on low performance of students in schools. Parents also blame teachers and schools' administrators, on why students are not performing better in schools. Factors affecting students' performance are student factors, teacher factors, societal factors, the governmental infrastructural problem, language problem, examination body related variables, curriculum related variables, test related variables, textbook related variables and home related variables. This study therefore investigated the effectiveness of Guided Inquiry in Collaboration and Problem Based Learning on Academic Performance.

Objectives of the Study

The objective of the study was to determine; effectiveness of guided inquiry method in collaboration and problem-based learning on academic performance of senior secondary school chemistry students in Maiduguri metropolis, Borno state, Nigeria.

Research Questions

The following research question was answered:
What is the effectiveness of guided inquiry in collaboration and problem based learning on Academic performance of senior secondary school chemistry students?



Hypothesis

H₀₁: There is no significant difference in the effectiveness of guided inquiry in collaboration and problem-based learning on academic performance of senior secondary 2 chemistry students in Maiduguri metropolis, Borno state, Nigeria.

Methodology

The study used quasi-experimental design, specifically, utilizing pre-test and post-test to assess the performance of students instructed in Chemistry. The population for study was 14,525 during the 2022/2023 academic session comprising Chemistry students from 13 public Senior Secondary Schools in Maiduguri Metropolis, Borno State, Nigeria.

The instrument used for data collection was developed by the researcher tagged Chemistry Performance Test (CPT) in Maiduguri Metropolis in Borno state. According to Shieh (2018) a performance assessment should allow students to demonstrate knowledge and skills, including the process by which they solve problems. The instrument consisted of two (2) sections, A and B. Section, A consist of demographic data of the respondents while section B contains data required for the study, which consist of 25 items of multiple-choice. Two (2) intact classes were used in each of the three (3) schools. The number of experimental and control groups were selected from the three (3) sampled schools using simple random sampling technique.

Classes were randomly selected and assigned to experimental and control groups. Class A was assigned as experimental group in each sampled school while second group B was assigned as control group in each of the three (3) sampled schools. The data collected were analyzed using descriptive statistics, such as mean and standard deviation to address research question. Additionally, inferential statistics, specifically the ANCOVA was used to test hypotheses at 0.05 significance level.



What is the Effectiveness of guided inquiry in Collaboration and Problem Based Learning on Academic performance of senior secondary school Chemistry students?

Table1: Summary of mean and standard deviation of Effect of Guided Inquiry Method in

Collaboration and Problem Based Learning on Academic Performance of Senior Secondary 2 Chemistry Students

Guided Inquiry Method	N	Mean	Standard Deviation
Pre-test	160	46.21	9.31
Post-test	160	73.05	11.13

Table1: presents a summary of the mean and standard deviation of the effect of the Guided Inquiry Method in collaboration and problem-based learning of teaching on the academic performance of senior secondary school chemistry students. The pre-test results, based on a sample size of 160 students, indicated a mean score of 46.21 (SD = 9.31). After the intervention of the Guided Inquiry Method, the post-test mean score based on 160 students increased to 73.05 (SD = 11.13) for the same sample. The higher post-test mean suggests a positive effect of the Guided Inquiry Method on the academic performance of the students.

Hypothesis 1 (H₀₁): There is no significant difference in the effectiveness of guided inquiry in Collaboration and problem Based Learning on Academic Performance of Senior Secondary school Chemistry Students in Maiduguri Metropolis, Borno State.

Table 2: Summary of Effectiveness of Guided Inquiry in Collaboration and problem Based Learning on Academic Performance of Senior Secondary 2 Chemistry Students in Maiduguri Borno State

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Squared	Eta
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Corrected Model	2857.217a	31	92.168	1.048	.003	.537
Intercept	162505.918	1	162505.918	1847.120	.000	.985
Pretest	848.023	19	44.633	.507	.006	.256
Groups	651.410	1	651.410	7.404	.00	.209
Error	1103.996	11	100.363	1.141	.009	.309
Total	2857.217a	280	92.168	1.048	.003	.537
Corrected Total	162505.918	279	162505.918	1847.120	.000	.985

a. R Squared = .537 (Adjusted R Squared = .054)

Tab 2. presents the ANCOVA results which indicated a significant difference in academic performance of students taught using Guided Inquiry in collaboration problem learning ($F(1, 11) = 7.404, p < .01, \eta^2 = .537$). Post-hoc tests revealed a substantial mean ($M = -34.090, SE = 0.281, p < .001$), shows that the Guided Inquiry method in Collaboration and problem Based Learning led to significantly higher academic performance. Hence, the null hypothesis which states that there is no significant difference in the guided inquiry in collaboration and problem-based learning on Academic Performance of Senior Secondary 2 Chemistry Students is hereby rejected.

Discussion

The study effectiveness of Guided Inquiry Methods in collaboration and problem-based learning on Academic Performance of Senior Secondary 2 Chemistry Students in Maiduguri Metropolis, Borno State, Nigeria. The study was based on the theory of constructivism learning developed by Dewey (1938). The theory holds that education is a social process that changes society



as well as adult's role of society, shifting responsibilities of education from parents to teacher and from family to school. Societies change its effective use of education in designing, developing, producing, implementing and evaluating curriculum.

The result of this study on effectiveness of guided inquiry method in collaboration and problem-based learning on academic performance of senior secondary 2 chemistry students revealed that the guided inquiry method of teaching had effective impact on the academic performance of senior secondary 2 chemistry students. This result agrees with the findings of Ibiyengibo (2019) who reported that there is a significant effect of guided inquiry as an instructional approach, it leads to a substantial improvement in students' academic achievements. Upon closer examination of the data, it becomes evident that students who were exposed to guided inquiry instruction performed better and also exhibited higher mean scores in post-test. The statistical significance of this difference is underscored by the impressively small p-value of 0.000, which indicates that observed improvement is not due to chance. It is highly plausible that the guided inquiry method fostered active learning, encouraged critical thinking, and honed problem-solving skills among the students, contributing significantly to their enhanced performance.

This finding underscores the effectiveness of guided inquiry in collaboration and problembased learning in promoting better academic outcomes, as students who received guided inquiry instruction significantly outperformed their peers. This discovery is consistent with the results of a study conducted by Ibiyengibo in (2019), which explored the impact of the guided-inquiry approach on chemistry students' performance. It underscores the importance of choosing the appropriate teaching method based on desired learning outcomes and student needs, as guided inquiry in collaboration and problem-based learning emerges as a highly effective approach for improving academic achievement in chemistry. This implies that the experimental group taught chemistry using inquiry method inquiry in collaboration and problem-based learning instruction achieved significantly. This had answered the first research question that is there is a significant



difference in the mean scores of the students taught chemistry concepts using guided inquiry teaching method in collaboration and problem-based learning.

Conclusions

Based on the findings, it was concluded that there were positive and effective impact observed with the guided inquiry method in collaboration and problem-based learning in teaching senior secondary 2 chemistry students underscore its potential as a valuable instructional approach for enhancing academic performance in this educational context. contributing to favorable learning outcomes. The significant effectiveness demonstrated by guided inquiry method in collaboration and problem-based learning in improving the academic performance of senior secondary school chemistry students emphasizes the importance of employing a diversified instructional approach to cater to various learning styles and preferences.

Recommendations

Based on the finding of the study, these are the following recommendations:

1. It is recommended that educators incorporate more active and inquiry-based learning approaches in their teaching.
2. Educators should encourage students to explore and question concepts on their own, engage in group discussions, and conduct experiments whenever possible.
3. Teachers are to provide ample opportunities for students to apply their knowledge through hands-on activities and real-life problem-solving exercises.
4. Overall, it is important for teachers to be flexible in their instructional strategies and tailor their approaches to meet the diverse needs and learning styles of students.



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