Hindawi
Journal of Chemistry
Volume 2023, Article ID 9970946, 8 pages
https://doi.org/10.1155/2023/9970946

Research Article

Interactive Effects of Guided Inquiry and Teachers' Experience on Chemistry Students' Interest

Benson Ikechukwu Igboanugo

Department of Science Education, Alex Ekwueme Federal University, Ndufu-Alike P M B 1010, Abakaliki, Ebonyi State, Nigeria

Correspondence should be addressed to Benson Ikechukwu Igboanugo; benikigboanugo@yahoo.com

Received 4 February 2023; Revised 8 May 2023; Accepted 12 July 2023; Published 20 July 2023

Academic Editor: Gabriel Navarrete-Vazquez

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The dwindling of students' interest in chemistry which leads to students poor achievement in chemistry calls for an inward investigation on the interactive effects of two influential factors on pedagogy, effective mode of instruction and the teacher quality on students' interest in chemistry. Thus, this study adopted the quasiexperimental design to investigate interactive effects of guided inquiry and teachers' years of experience on students' interest in chemistry. The study was conducted using Senior Secondary School 2 chemistry students in Ogidi Education zone of Anambra state, Nigeria. One research question and one hypothesis guided the study. 310 chemistry students random sampled in twelve public secondary schools and twelve regular teachers were included in the study. Data were collected using validated chemistry interest inventory (CII). The CII had an average reliability index of 0.93 as determined using Cronbach's alpha reliability coefficient. The hypothesis was tested using the analysis of covariance (ANCOVA). The study revealed significant interactive effects of teachers' years of experience and guided inquiry on students' interest in chemistry.

1. Introduction

Chemistry as the fulcrum of science and technology and the bedrock for nation development demands for a continuous payment of proper attention to its teaching and learning for the effective realization of its instructional aims and objectives in schools. Chemistry is a utility science subject highly valued in important professions such as medicine, pharmacy, engineering, food science, home economics, and agriculture. Chemistry embodies knowledge, attitudes, and skills which are vital for human development and nation building [1]. The utility nature of chemistry demands the acquisition of the science process skills, knowledge, and science attitudes. Most of the science process skills are complex such that the acquisition requires several rigorous exercises [2]. Njoku and Ugwu [3] attest to the complex nature of the chemistry contents which results in learner's loss of interest and poor performance in chemistry. Learners' poor performance in some chemistry contents such as organic chemistry, chemical equations, and electrolysis is an indication of the complex and difficult nature of chemistry which could result in a low level of interest in the learner [4]. The acquisition of science attitudes such as probing, questioning, experimenting, and logical reasoning by the learner through chemistry are so demanding that the provision of an atmosphere to intrigue the learner during chemistry instruction is imperative. The tasks involved in chemistry instruction are so challenging that the learner can easily become fatigued and lose interest during chemistry instruction [5].

The present global economic recession and some other factors such as poor teacher qualification and an inadequate learning environment tend to dampen the interest of young citizens in the pursuit of education, especially the study of sciences [6]. Consequently, there is an observed dwindling of interest among young citizens in learning science across the globe [6, 7]. This jeopardizes the chances of having young citizens who will be enrolled into science-oriented professions such as medicine, engineering, pharmacy, food science, and agriculture. The situation demands serious

continual search for pedagogical strategies to generate and sustain the young citizens' interest in pursuit of science education especially chemistry.

Interest is a construct that refers to the feeling of wanting to know or learn more about something or somebody; it is a characteristic feeling that arouses concern or curiosity and holds one's attention. It could be aroused in an individual by an activity that tends to satisfy the individual's needs [8]. Suwaid and Danbata [9] maintain that interest could be demonstrated by showing curiosity, concern, and patience towards all challenges accompanying the achievement of the goals especially in the classroom. Furthermore, Ogbonne and Oforma [10] opine that interest is an important variable needed to realize academic outcomes. It is an aspect of the important affective domain which comes into play when the teacher critically considers the specific objectives of a lesson. The implication from the foregoing is that a lack of interest can inhibit realization of learning outcomes in chemistry. Thus, the learner needs rekindled and sustained interest to withstand the rigorous exercises required in learning the intricate networks of topics/concepts, skills, and attitudes in chemistry. Again, the permanent change in behaviour expected of the learner by the teacher can be sustained by the learners' interest.

Students' lack of interest in learning chemistry leads to poor academic achievement in chemistry and a shortage of human resources in key science professions [5, 11]. Consequently, there is a low number of students who qualify for enrollment into some chemistry-oriented courses such as Medicine and Engineering in higher institutions of learning within Nigeria and some other underdeveloped nations [12]. Conscious efforts are needed to prepare learners who will be useful and qualified to pursue important chemistry-oriented courses at the higher education level by capturing and sustaining their interest during chemistry instruction.

Factors that militate against learners' interest in chemistry are identified to include teachers' inability to use appropriate instructional approaches and unavailability of effective teaching resources [8, 13]. This corroborates with Holden et al. [14], who maintain that interest is built and sustained in the learner through adequate chemistry teacher qualification and disposition; use of reinforcement; making the content relevant to the needs and aspirations of the learner; and appropriate use of suitable instructional approach and resources.

The teacher quality reflects the quality of instruction [14, 15]. The teacher quality which can influence chemistry instruction includes academic qualification and years of experience. These two qualities according to Nwogu [13] validate the quality of the education system. The teachers' years of experience refers to the period the teacher has been consistently involved in piloting instructions using different modes of instruction and strategies to realize the aims and objectives of teaching and learning.

The mode of instruction is a vital tool for the attainment of selected goals and objectives in teaching and learning chemistry. There are various modes of instruction available for the chemistry teacher to adopt which include expository, demonstration, excursion, and discussion. Other modes of instruction are cooperative learning, peer-teaching, concept mapping, computer-assisted instruction, and guided inquiry [16, 17]. An effective mode of instruction should appeal to the learner's interest.

The guided inquiry demands that students are given a problem to solve and sometimes the necessary materials; they design their own procedures, collect related data, and formulate hypotheses. The teacher guides the students with orientating questions. By doing so, guided inquiry ensures full engagement of the learner in a given task and enhances students' acquisition of science process skills [18, 19].

The guided inquiry mode of instruction is based on the constructivists' approach to learning which advocates for learner-centred instruction. It is based on the constructivist views of learning such as Vygotsky's [20] theory of learning which allows the learners to exercise a high level of freedom in critical thinking, creativity, and problem solving. One of the assumptions of Vygotsky's theory is the cognitive development which stems from social interactions and guided learning within the zone of proximal development as the child and his/her partners coconstruct knowledge. The teacher who uses the guided inquiry mode of instruction initiates compelling situations and questions which meaningfully engage students in wanting to know and becoming challenged. The challenged student is engaged in thinking, acting, reflecting, discovering and linking ideas, making connections, and developing and transforming prior knowledge, skills, attitudes, and values. Higher-order thinking and critical analysis occur throughout the guided inquiry instruction [21]. The learning activity should closely resemble the way the student will be expected to use their knowledge and skills in the real world. Guided inquiry develops learner's abilities for further exploration [22]. Thus, the use of guided inquiry mode of instruction in teaching and learning chemistry might be a stimulus for learners' interest to be captured and sustained. However, the effectiveness of the guided inquiry method might depend on the teacher's ability.

Most countries across the globe including Australia and Nigeria have initiated the move to use guided inquiry in teaching and learning [23, 24]. Fitzgerald [24] observed the absence of a process approach to guided inquiry in some curricula across nations. Fitzgerald suggested four elements of guided inquiry design (GID) which include

(1) Inquiring: identifying, exploring, and organizing information and ideas

(2) Generating ideas, possibilities, and actions

(3) Analyzing, synthesizing and evaluating, reasoning, and procedures

(4) Reflecting and thinking processes.

The GID is shown in Figure 1. The teacher guides the learner through the four elements of GID. In the first step, the learner is guided to, through inquiring, exploring, and organizing information and ideas on a learning task. This is followed by the second step of generation of ideas, possibilities, and actions by the learner. In the third step, the learner through the application of reasons and procedures,

analyzes, synthesizes, and evaluates results. Finally, the learner has deep thoughts and reflections on the result generated in the third stage which could lead to further inquiry and a repeat of the steps to get satisfaction.

2. Review of the Literature

Pamenang et al. [22] considered the effectiveness and importance of guided inquiry in chemistry practicum. Consequently, the authors developed a chemical equilibrium practicum module based on guided inquiry to explore students' abilities in designing experiments.

Abdulrahman [25] investigated the effect of inquiry-based instruction on secondary school students' acquisition of science process skills in biology. The study adopted a quasiexperimental design involving pretest, posttest, and control groups. The study found a significant difference in the mean scores of science process skills acquisition between subjects in the experimental and control groups.

Anudu et al. [26] investigated the effect of the guided inquiry method of teaching ecological concepts on the acquisition of science process skills by biology students. The study was conducted using SS2 biology students. The study found that the guided inquiry method of teaching was a significant factor in student's science process skills acquisition in ecology.

From the literature, much empirical work has not been done on the teachers' years of experience and guided inquiry on students' interest in chemistry. An empirical study on teachers' years of experience and the use of guided inquiry on chemistry students' interest might yield important results that will aid stakeholders in chemistry education and education in general toward improvement of students' interest in chemistry for optimum realization of education objectives. From the foregoing, there is the pertinent question that might arise: What interactive effects does the guided inquiry mode of instruction have with teachers' years of experience on students' interest in chemistry? The question ought to be explored fully so as to improve the efficacy of guided inquiry mode of instruction on chemistry students' interest and sensitize stakeholders in chemistry education on measures of developing and sustaining students' interest in chemistry for optimum learning outcomes.

2.1. Problem of the Study. Researchers have confirmed and suggested some modes of instructions to improve learners' interest in chemistry. However, there persists learners' lack of interest in chemistry across the globe, most especially in Nigeria because of teachers' inability to use effective modes of instruction. This is an indication that the effectiveness of such modes of instruction might depend on the ability of the teacher to use the appropriate mode of instruction such as guided inquiry to boost the interest of students in chemistry. Thus, the problem of this study was to investigate the effects of the influence of teachers' years of experience over guided inquiry on students' interest in chemistry.

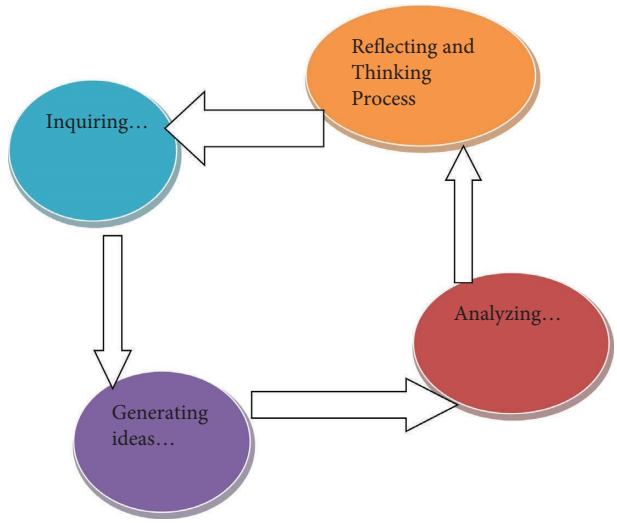

Figure 1: Guided inquiry design.

2.2. Research Question. The study was guided by the following research question:

What are the interactive effects of guided inquiry and teachers' years of experience on students' interest in chemistry?

2.3. Hypothesis. The following null hypothesis was formulated and tested at an alpha level of 0.05:

HO: There is no significant interactive effect of guided inquiry and teachers' years of experience on students' interest in chemistry.

2.4. Methodology. A quasiexperimental design was adopted for this study because intact classes were used which would not allow the researcher to fully randomize the subjects. Specifically, the pretest, posttest, nonequivalent control group design was used for the study. The design is represented as follows:

$$\begin{aligned} &O_b X O_a, \\ &-\,-\,-\,-\,-, \\ &O_b \sim X O_a. \end{aligned} \tag{1}$$

X = treatment (guided inquiry). ~X = control (conventional instructional approach). O_b = pretest measurement. O_a = posttest measurement. ------- = indication that treatment and control groups are not obtained by random assignment of subjects to conditions.

The population of the study comprised all SSS2 chemistry students in Ogidi Education zone of Anambra State, Nigeria. The choice of Senior Secondary School (SSS2) was made because among the three sections of Senior Secondary School, SSS1 was the fresher chemistry class where the decision to continue with chemistry may not have been taken by the learner. SSS3 was a class for the final external examination which was not disposed for research work.

Thus, SSS2 became the best option for selection in this study. A sample of 310 SSS2 chemistry students from twelve secondary schools and twelve regular chemistry teachers was used in the study. The schools were drawn from the thirty-three public schools in the education zone by simple random sampling. The choice of public schools was made because public schools are under the same control and provisions of the Post-Primary Schools Service Commission. Treatment and control groups were assigned to the schools at random. Six schools were assigned to the treatment group, and the remaining six schools were assigned to the control group. The chemistry teachers' years of experience from the schools were obtained using a questionnaire followed by their categorization into low experience, medium experience, and high experience as follows: 0–4 years (low experience), 5 teachers; 5–9 years (medium experience), 3 teachers; 10 years and above (high experience), 4 teachers. Approval was obtained from the school principals to use their schools for the study.

2.5. Instrument for Data Collection. The instrument used to collect data for the study was the chemistry interest inventory (CII) adopted from Igboanugo [27]. The instrument comprised of two sections, sections A and B. Section A sought for personal data of the subjects while section B comprised of instructions and items with their options. The CII was made up of 30 items that covered students' interest in chemistry. Such items include, "I am willing to read chemistry books at my free time; I feel happy in a chemistry class; I would not accept to work in the chemical industry." The CII was a four-point scale. Each item has the options of, strongly agree, agree, disagree, and strongly disagree. The scale for the options was: strongly agree, 4 points; agree, 3 points; disagree, 2 points, and strongly disagree, 1 point for positive statements while the reverse was the case for negative statements.

The instrument was face validated by two experts in chemistry education, one expert in educational measurement and evaluation, and two secondary school chemistry teachers. The face validation was to ensure that each of the items was understandable and relevant to the SSS2 students who were the subjects for the study. The instrument was trial-tested on 33 SSS2 students of a secondary school outside the zone of study. The trial test helped to improve the quality of the items, language clarity, and conformity of items to the level of the students and confirm the face validity of the items. Again from the results of the trial test, reliability index of the instrument was determined using Cronbach's alpha reliability coefficient to be an average of 0.93.

3. Experimental Procedure

Two modes of instruction were used for the study. Guided inquiry was used in teaching the experimental group while expository mode of instruction was used in teaching the control group. The regular chemistry teachers were used in this study to teach their respective regular classes. This arrangement has an advantage of removing the Hawthorne effect which might occur when a strange teacher teaches the students. The teachers in the experimental group were trained for three weeks to conform strictly to the guided inquiry lesson plan as prepared by the researcher. In the course of the guided inquiry lesson, the students were exposed to the following concepts and subtopics in electrolysis: electrodes; electrolytes; ions; electrons; mole; electrolytic cell; electrochemical cell; oxidation-reduction; balancing of equations; electrochemical series; migration and discharge of ions; laws of electrolysis; calculations; plotting, drawing, and interpreting graphs; electrolysis of acidified water, sodium hydroxide solution, brine, copper (II) sulfate solution; and uses of electrolysis. Most of these concepts and subtopics in electrolysis are abstract and cut across different areas of chemistry. Students in the experimental group were placed in five member groups and were provided with instructional materials and guided inquiry activities in which the students were involved in collection of electrodes such as carbon and zinc, the preparation of different electrolytes, setting up electrolytic cells and electrochemical cells, recording current, time, and volume of gases during electrolysis, plotting and interpreting graphs, and verifying the laws of electrolysis. The students were encouraged to use the Internet and the library facilities to complete home assignments. The teacher received the take-home assignments for grading.

In the control group, the same content, electrolysis taught in the experimental group, was taught by their teachers using the expository mode of instruction. A pretest was administered to the subjects in both groups using the validated CII, and the scores obtained were recorded before the experiment commenced. The experiment was carried out during normal school hours using the school timetable for the classes. The experiment lasted for eight weeks. On the last day of the experiment, a posttest was administered to the subjects using the validated CII, and the scores obtained were recorded. The CII used in the posttest was the same in content as the CII used in the pretest but differed in the sequence of items. Data collected from the pretest and the posttest were used to answer the research questions and test the hypothesis.

3.1. Data Analysis. The analysis of the result was done using the Statistical Package for Social Sciences (SPSS) version 22.0. The research question was answered using the mean and standard interest deviation. In order to test the hypothesis, the responses of the subjects in both the experimental and control groups were collated on statistical coding sheets on the basis of scoring levels. The set of data was then subjected to analysis of covariance (ANCOVA) which is a tool capable of controlling the existing pretests as covariates. Two-way ANCOVA was used because two independent variables (teaching method and teachers' years of experience) were involved.

3.2. Ethical Considerations. The consent of the school authorities of the schools used in this study was first obtained before using the schools. Also, the teachers of the schools willingly gave their assistance to the researcher.

4. Results

The results of the study are presented in Tables 1–3.

Research question: What are the interest mean scores of students in chemistry due to interactive effects of teachers' years of experience and guided inquiry?

The results presented in Table 1 show that the interest gain mean scores in the experimental group were 24.30, 33.27, and 33.58 for students taught by low-experience teachers, medium-experience teachers, and high-experience teachers, respectively, while in the control group, students taught by low-experience teachers, medium-experience teachers, and high-experience teachers had gained mean scores of −8.22, −0.74, and 2.29, respectively. Thus, chemistry students taught by the high-experience teachers had the highest interest gain mean score followed by those taught by medium-experience teachers while the chemistry students taught by low-experience teachers had the least interest gain mean score. The difference in the standard deviation indicates variations in the clustering of the scores around the mean scores of each group. Table 2 shows that the observed differences in the interest gain mean scores between students taught by teachers with different years of experience is significant (F (2, 303) = 11.948, $P = 0.001$). The observed differences in the pretests could be as a result of factors such as, differences in the school location and facilities, students' background, and Hawthorne effect due to a teacher's relative newness in the school.

4.1. Hypothesis. The interactive effect of teachers' years of experience and guided inquiry on students' interest in chemistry is not significant ($P < 0.05$).

The results in Table 2 show that the exact probability value of 0.001 associated with methods (modes of instruction) by teacher experience interactive effect is less than 0.05 level of significance (F (2, 303) = 12.109, $P = 0.001$). Thus, the null hypothesis of no significant interactive effect of methods and teacher experience on students' interest in chemistry is rejected. The researcher, therefore, concludes that the interactive effect of teachers' years of experience and guided inquiry on students' interest in chemistry is significant. To determine the direction of observed significant difference in the interest mean scores with teacher experience; (F (2, 303) = 12.109, $P = 0.001$), a post hoc analysis was done as shown in Table 3. The post hoc analysis shows that students taught by medium-experience teachers scored significantly higher than students taught by low-experience teachers at $P < 0.005$. While there was no significant difference between the interest mean score of students taught by medium-experience teachers and the interest mean score of students taught by high-experience teachers at $P < 0.005$. Furthermore, there was a significant difference between the interest mean score of students taught by high-experience teachers and interest mean score of students taught by low-experience teachers at $P < 0.005$. Tables 1–3 show that the teacher's years of experience interact with guided inquiry to generate students' interest in learning chemistry.

5. Discussion of Findings

Table 1 shows that students taught chemistry using guided inquiry by teachers with various years of experience had different interest mean scores. Students taught by high-experience teachers had the highest interest mean score followed by those taught by medium-experience teachers while students taught by low-experience teachers had the least mean interest score.

The interactive effect of teachers' year of experience and guided inquiry on students' interest in chemistry is significant, as further confirmed by the result in Table 2 which revealed significant difference in the mean interest scores (F (2, 303) = 12.109, $P = 0.001$) of students in chemistry taught using guided inquiry by teachers with different years of experience. This result implied that effective use of guided inquiry in developing and sustaining students' interest in chemistry would depend on the teachers' years of experience which increases as the teachers' years of experience increases. The findings of this study conformed to Ogbonnaya [15] who indicates a significant positive relationship between students' academic achievement in mathematics and teachers' background such as teachers' qualifications and years of experience. The study is also in consent with Nwogu [13] who reveals that the teachers' years of experience significantly influences students' academic achievement. Students taught by teachers with less than five years of experience achieved poorly while students taught by teachers with experience above five years improved their academic achievement. However, the present study reveals that the difference between the interest mean score of students taught by medium-experience teachers and the interest mean score of students taught by high-experience teachers is not significant. This conforms with Igboanugo [5] who opined that science teachers with high experience are always assigned some administrative duties such as the head teacher, the dean of studies, and the school registrar which interferes with the teacher's readiness for classroom instruction.

The education implication of this study's finding is that the skills and readiness required for the effective use of guided inquiry in developing students' interest in chemistry increase with the increase in teachers' years of experience. As the teacher's years of experience increases his/her ability and skills in presenting learning experiences in a manner that develops the learner's interest increase. Experienced chemistry teachers should be saddled with administrative duties in the school.

5.1. Implications of the Study. Based on the findings of this study, implications made for students, chemistry teachers, policy makers, and government include confirmation that the teacher's years of experience could influence teachers' effectiveness in using guided inquiry to improve students' interest in chemistry. Through an adequate number of years of experience, the teacher acquires the necessary skills and knowledge required for effective use of the guided inquiry mode of instruction in improving the students' interest in

Table 1: Mean and standard deviation of students' interest scores in chemistry due to interactive effects of teacher experience and modes of instruction.

Groups	Teacher experience	Pretest		Posttest		Gain mean score	Number of subjects
		Mean	Std. dev.	Mean	Std. dev.		
Experimental	Low	60.06	15.09	84.36	14.73	24.30	47
	Medium	54.16	5.50	87.43	7.03	33.27	57
	High	53.92	4.73	87.50	9.75	33.58	53
Control	Low	81.76	10.20	73.54	13.93	−8.22	54
	Medium	81.64	8.25	80.90	13.58	−0.74	42
	High	61.32	5.31	63.61	7.95	2.29	57

Table 2: Summary of analysis of covariance (ANCOVA) of interactive effects of teacher experience and mode of instruction on students' interest in chemistry.

Source	Type III sum of squares	D*f*	Mean square	*F*	Sig.
Corrected model	24522.546[a]	6	4087.091	31.726	0.001
Intercept	31277.840	1	31277.840	242.792	0.001
Pretest interest	44.534	1	44.534	0.346	0.557
Mode of instruction	7485.547	1	7485.547	58.106	0.001
Teacher experience	3078.338	2	1539.169	11.948	0.001
Mode of instruction ∗ teacher experience	3119.955	2	1559.978	12.109	0.001
Error	39034.151	303	128.826		
Total	2012830.000	310			
Corrected total	63556.697	309			

[a]*R* Squared = .386 (adjusted *R* squared = .374).

Table 3: Post hoc analysis on Students' mean interest scores by teacher experience dependent variable:postestint.

(I) Teacher experience	(J) Teacher experience	Mean difference (I – J)	Std. Error	Sig.[a]	95% confidence interval for difference[a]	
					Lower bound	Upper bound
Low	Medium	−5.354*	1.632	0.001	−8.566	−2.142
	High	−5.805*	1.853	0.131	−0.842	6.453
Medium	Low	5.354*	1.632	0.001	2.142	8.566
	High	4.160	1.758	0.000	4.700	11.619
High	Low	5.805*	1.853	0.131	−6.453	0.842
	Medium	4.160	1.758	0.000	−11.619	−4.700

Based on estimated marginal means.*The mean difference is significant at the 0.05 level. [a]Adjustment for multiple comparisons: least significant difference (equivalent to no adjustments).

chemistry. The implication to the student is that students' interest in chemistry can be improved when chemistry instruction is done by teachers using guided inquiry. This by implication gives credence to the constructivist theory which provides the underlining principle for the guided inquiry mode of instruction. Policymakers and the government can be directed right in taking decisions on teachers' experience and the use of guided inquiry mode of instruction.

5.2. Recommendations. Based on the findings of this study, the following recommendations are made.

(1) School owners and professional bodies such as Science Teachers Association and Ministry of Education should organize conferences, seminars, and workshops for cross-fertilization of experiences and ideas among chemistry teachers with different years of experience on the effective use of guided inquiry in generating and sustaining students' interest in chemistry.

(2) Team teaching should be encouraged among chemistry teachers by the school management for cross-fertilization of ideas and experiences on the use

of guided inquiry for building students' interest in chemistry.

(3) Years of experience should be a yardstick for distribution of teachers in schools. This is to ensure that a given sect of teachers is not clustered at a given school or sect of schools.

6. Conclusion

The importance of building and sustaining interest in overcoming human herculean endeavour such as learning cannot be relegated to the background. A lack of interest is identified as an unbecoming in chemistry instruction even after successful research on the use effective modes of instruction. This study has delved into finding out the interactive effects of guided inquiry and teachers' years of experience on students' interest in chemistry. Results of this study have shown that the interactive effect of teachers' years of experience and guided inquiry on students' interest in chemistry is significant ($F\ (2,\ 303) = 12.109,\ P = 0.001$) at $P < 0.05$. Again, students' interest significantly increases as the teachers' years of experience increase. This suggests that teachers' effectiveness in using guided inquiry depends on their years of experience. This result has led to some suggestions made in the study for improvement in chemistry instruction outcomes and a better education system at large.

Data Availability

The data used in this study are readily available and can always be presented on demand.

Additional Points

The major limitations of the study which may call for further investigations include: (1) The number of teachers used in the study was twelve. The result of the study might be affected if the number of teachers used is larger. (2) Subjects' interest in the study might have been influenced by factors such as different class sizes and different family backgrounds not considered in this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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