THE IMPACT OF INQUIRY-BASED METHOD OF TEACHING ON THE ACADEMIC PERFORMANCE OF PRIMARY EDUCATION STUDENTS OF ATEBUBU COLLEGE OF EDUCATION IN GENERAL CHEMISTRY

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ABSTRACT

This study investigated the impact of inquiry-based method of teaching on general chemistry concepts in the Atebubu College of Education using quasi-experimental and control group design. Primary education students in level 100, consisting of one hundred and fifty-five (155) were used in the study. General Chemistry Performance Test (GCPT) was used to assess the performance of experimental and control groups. The data obtained were analysed using mean, standard deviation and a paired sample t-test at 0.05 level of significance. From the results of the study, the inquiry-based method proved an effective method of teaching, enhancing students' performance than a lecture method. Again, no significant difference was seen in the performance of gender in the experimental group taught by inquiry-based-method of teaching, however, the males of the control group taught by lecture method performed significantly better than their female counterparts. The study, therefore recommends the use of inquiry-based method in the teaching and learning of general chemistry at the Colleges of Education to foster student-teachers the opportunity to solve problem and enhance their performance in chemistry and other related courses.

Keywords: Inquiry-based method, lecture-method, professional knowledge and critical thinking.

1.0 INTRODUCTION

Science educators worldwide have strived so hard to adopt suitable methods of teaching to deliver different scientific concepts to students at all levels of education, having identified numerous benefits derived from the acquisition of such scientific knowledge. It is common nowadays, to find professional science teachers holding firmly to only traditional lecture methods of teaching, which result in unproductivity due to its inability to foster problem solving, critical thinking and creative thinking (Wood & Gentile, 2003).

Employers nowadays, complain bitterly about today's graduates lacking the basic skills, particularly communication, problem-solving, ability to prioritise tasks and decision making (Selingo, 2015). The ill-performance of products from institutions cannot solely be blamed on the graduates but the training received from their handlers as well, since the teaching and learning in majorities of the schools in Ghana are teacher-cantered. The Ministry of Education, in their quest to strengthen the education systems at basic level, have reformed not only the curriculum of the basic schools but the Colleges of Education as well, to equip student-teachers

the requisite professional knowledge, skills and values needed to make them useful in today's complex classroom settings (Armah, 2018).

There is no doubt that the visioning behind the new curriculum is to modify and improve upon the existing one. However, the implementation of every new curriculum in Ghana, usually affects pioneering students' performance at every level of education, with the method of teaching taken the lion-share of the failure. The four-year bachelor of education programme, being run by the Colleges of Education, offer primary education student teachers the opportunity to pursue general chemistry, which most students tagged as abstract course. The abstract nature of chemistry as claimed by students and most teachers is possibly because of the ways it is taught and learnt - not relating it to day to day activities of the learner resulting in students' poor performance in the subject (Ugwu & Diovu, 2013). This, therefore, calls for a more practical approach, an inquiry method which offers learners hands-on activities that promote concepts discoveries and arouse and sustain learners interest throughout the implementation of the new curriculum. Even though similar work has been made in chemistry and biology in senior secondary schools in Africa (Ugwu & Diovu, 2013; Ghumdia, 2016), no work of this sort has been made in the teaching of general chemistry at the Colleges of Education.

This study is aimed at investigating the impact of inquiry-based method of teaching on general chemistry concepts at Atebubu College of Education.

Inquiry, as put forward by Hiang (2005) includes investigation of a problem; finding truth or knowledge that requires thinking critically, making observations, asking questions, doing experiments and drawing conclusions; and thinking creatively and using intuition.

The use of inquiry method of teaching is spear-headed by constructivists who hold that learners actively construct or make their own knowledge through their experience. In the inquiry approach to teaching, the teacher's role in the classroom shifts from an information provider or an instructor to a facilitator and a guide, who create a conducive environment, where learners themselves create their knowledge (Shinde, 2020). Orton (2004) in support of constructivists stated that students have the clear chance to make use of their pre-existing knowledge, encounters, findings and conceptions to construct new concepts formation which is in sharp contrast to the behaviourists who supports acquisition of concept (knowledge) through direct teaching.

A prominent school of thought argue that classroom facilitators should resort to the use of inquiry-based method of teaching which offers the learners the opportunity to interact with available materials to come out with facts and finding, which promotes understanding (Jerrim *et al*., 2020). A subject is taught at schools not only to produce little living libraries on that subject, but rather to get a student to think for himself, to consider matters and takes part in the process of knowledge-getting (Witt & Ulmer, 2010).

Inquiry approach to teaching is of numerous benefits to the total development of students. Through the inquiry approach to teaching, students learn best, since they take active roles and practice what they have learnt (Smart & Csapo, 2007). It also improves students' attitudes towards science and related subjects and enhances interest, curiosity and liking for the subject (Nurshamshida *et al*., 2012). Inquiry-based teaching places the student at the centre of the learning and the teacher serves as the guide.

Even though inquiry-based teaching has numerous benefits, it is however, time consuming in its usage (Baker *et al*., 2008) and increases the workload on teachers in administering the activities involved (Herman & Knobloch, 2004).

1.2 Purpose

The purpose of the study was to;

- Assess the impact of teaching strategies on student-teachers' academic performance in chemistry: inquiry-based method and lecture method of teaching.
- Identify the effects inquiry-based method and lecture method of teaching on the performance of gender in chemistry.

1.3 Research Questions

The following research questions were formulated to guide the study:

1. What is the difference in the academic performance mean score of student-teachers taught by using inquiry-based method and lecture method in chemistry?
2. What is the difference between the academic performance mean scores of male and female student-teachers taught by inquiry-based method and those taught by lecture method?

1.4 Hypotheses

The following hypotheses were formulated for the study;

H_{O1}: There is no significant difference between the academic performance mean score of student-teachers taught by inquiry method and lecture method.

H_{O2}: There is no significant difference between the academic performance mean scores of male and female student-teachers taught by inquiry method and those taught by lecture method.

2.0 Methodology

The study was conducted in Atebubu College of Education using all level 100 student-teachers pursuing primary education course. The student-teachers were assigned to two groups i.e. experimental group and control group.

2.1 Research Design

Quasi-experimental and control group research design of pre-test and post-test was used. The population targeted for the study was the entire level 100 primary education student-teachers (155). The choice of level 100 student-teachers was because the student-teachers at that level have been exposed to some basic chemistry concepts and skills in the integrated science at SHS which would enable them to solve basic problems in chemistry. Also, the level 100 student-teachers are at the transition stage from Senior High School to the College of Education, and are experienced in the lecture method of teaching since that had been the common method of teaching used by teachers.

2.2 Research Instruments

In order to ascertain groups' equivalence (ability level) in the design, samples were first pre-tested using General Chemistry Performance Test (GCPT). The population of the study was divided into two-experimental and control groups. Whiles the experimental group was exposed to inquiry-based method of teaching, the control group was exposed to lecture method of teaching. The treatment exercise lasted for eight weeks after which the two groups (experimental and control) were post-tested using the same General Chemistry Performance Test (GCPT) in different arrangement to assess the differences in their academic performance.

2.3 Validation of GCPT

The test items prepared on the course outline of general chemistry were 50 multiple choice questions. It was however, reduced to 40, after a careful edition and validation by colleague science tutors in the science department of the college to ascertain the content and construct validity of the instrument.

2.4 Reliability of the GCPT

The reliability of the GCPT was carried out using the test-retest method. In this approach, 20 primary education student-teachers from St. Monica's College of Education were pilot-tested with the GCPT and retested two weeks later. The reliability coefficient was computed using Pearson's Product Moment Correlation Coefficient (PPMCC).

2.5 Data collection and analyses

The data of the study was obtained from the General Chemistry Performance Test (GCPT). The performance of student-teachers was assessed by administering a pre-test and post-test that contained the same questions but arranged in different order. Having given the course outline of the semester to all the students used in the study, the pre-test was administered to 155 students used in the study, using GCPT.

After the administration of the pre-test, the experimental group was treated with the inquiry-based method of teaching on all the topics in the course outline whiles the control group were taken through lecture method of teaching on the course outline as well. The treatment lasted for eight weeks at two credit hours per week.

At the expiration of the treatment period, a post-test was given to both the experimental and control groups, using the GCPT used in the pre-test but different arrangement of the test items and under the same examination conditions as that of the pre-test. The data obtained from the study were analysed by using mean, standard deviation for the descriptive statistics to answer the research questions while paired sample t-test was used to test the hypotheses at 0.05 level of significance.

3.0 Results and Discussion

Research Question 1: What is the difference between the academic performance mean scores of student-teachers taught by inquiry and lecture method?
To answer this research question, the pre-test and post-test administered on the experimental and control groups were analysed using mean and standard deviation. The summary of the analysis is presented in Table 1:

Table 1: Summary Statistics of Pre-Test and Post-test Scores

Groups N=155	n	Pre-Test Mean	SD	Post-Test Mean	SD	Mean Achievement Gain	p-value
Experimental	80	10.788	3.217	25.625	7.492	14.837	<0.001*
Control	75	10.880	3.136	14.907	3.699	4.027	
Mean Difference		0.092		10.718			

N: Total number of students. n:sample of students. SD: Standard Deviation. p < 0.005 is statistically significant.
**t-test comparing post-test mean scores between the experimental and control groups*

Table 1 shows the mean scores of pre-test and post-test of the experimental and control groups. The mean scores of the experimental and control groups of the pre-test were 10.788 and 10.880 respectively, at a mean difference of 0.092. However, the mean score of the experimental and control groups in the post-test were 25.625 and 14.907, respectively, at a mean difference of 10.718. The mean achievement gain for experimental and control groups was 14.837 and 4.027 respectively.

The p-value of the post-test results of the experimental and control groups is significant at <0.001. Since p-value obtained is less than 0.05 significant level set for the hypothesis, the hypothesis is therefore rejected. This means, there is a significant difference in mean performance scores of student-teachers taught general chemistry with inquiry-based method and lecture method.

Research Question 2: What is the difference between the academic performance mean scores of male and female student-teachers taught by the inquiry-based method and those taught by lecture method?

To answer this research question, the pre-test and post-test administered on the male and female student-teachers of the experimental and control groups were analysed using mean and standard deviation. The summary of the analysis is presented in Table 2.

Table 2: Summary Statistics of Pre-Test and Post-Test Scores of Gender

Groups	Sex	n	Pre-Test		Post-Test		Mean Achievement	p-value
N=155			Mean	SD	Mean	SD	Gain	
Experimental	Male	38	11.263	3.454	26.026	10.44	14.763	0.652*
	Female	42	10.357	3.454	25.262	3.085	14.905	
Mean Difference			0.906		0.764			
Control	Male		10.816	3.003	16.526	3.804	5.71	<0.001*
	Female		10.946	3.308	13.243	2.763	2.297	
Mean Difference			0.13		3.283			

N: Total number of students. n:sample of students. SD: Standard Deviation. p < 0.005 is statistically significant.
**t test comparing mean marks scored between male and female for post-test.*

Table 2 above shows the mean scores of males and females of the experimental and control groups in both pre-test and post-test. The mean score of males and females of the experimental groups in the pre-test were 11.263 and 10.357, whereas that of the control group counterpart were 10.816 and 10.946 respectively. On the other hand, the mean score of males and females of the experimental groups in the post-test were 26.026 and 25.262 while that of the control group were 16.526 and 13.243 respectively. The mean achievement gain of the males and females of the experimental groups was 14.763 and 14.905 respectively, whiles that of the control group counterpart was 5.71 and 2.297.

The p-value of males and females scores of the experimental was not significant at 0.652. Since 0.652 is greater than 0.05 significant level set for the hypothesis, the hypothesis, is therefore accepted. This means, there is no significant difference in mean performance scores of males and females' student-teachers taught with the inquiry-based method in general chemistry.

However, there is a significant difference between males and females' student-teachers taught by lecture method at <0.001 level of significance. Since 0.001 is less than 0.05 significant level set for the hypothesis, the hypothesis is rejected.

The analysis and results of this study revealed that the experimental group taught by inquiry-based method performed significantly better than the control group taught by lecture method in general chemistry. The significant performance of in the experimental group could be attributed to the active participation of student-teachers in the teaching and learning process where they are offered the opportunity to practice what is learnt in the absence of the teacher, to discover new knowledge by themselves.

This finding align with the finding of Ghumdia (2016) who reported that that inquiry method of teaching improves students' attitudes towards science and related subjects and enhances interest, curiosity and liking for the subject. Again, the result is in agreement with the outcome of the study made by Ogumah *et al*. (2019). The inquiry-based method of teaching aids students to construct new concepts formation by using their pre-existing knowledge, encounters, findings and conceptions. Again, an inquiry-based method offers learners the various modalities such as visual, auditory and kinesthetics, through hands-on activities, which combine effectively to promote better understanding and sustain their interest and attention throughout the instructional activities.

The poor performance of the control group, on the other hand, may be attributed to teacher-centred approach used in the lecture method. This result agrees with the findings of Ghumdia (2016) and Ogumah *et al*. (2019). They claimed that that the lecture approach often compels learners to the passive recipient position of facts subjected down to him/her by the teachers. In the lecture method of teaching, majority of the instructional activities is done by the instructor which renders learners inactive recipient, hindering their constant practices in the absence of the teacher and resulting in loss of interest the subject.

The findings on gender in the study revealed that male students obtained a higher mean score than their female counterparts even though the difference was not significant. This may be due to the fact that the inquiry-based method of teaching offered fair interaction to both sexes in the study of general chemistry. This result agrees with the findings of Ibe (2004) and Ghumdia (2016) who found no significant difference in the performance of both sexes in the use of inquiry-based method of teaching. An inquiry-based approach provides equal level field to both males and females, which gives learners equal opportunities to interact with the teaching and learning materials during instructional activities, which enhance understanding. Inquiry-based method of teaching, therefore, check biases in the teaching and learning process. However, the male students in the control group performed significantly better than their female counterparts. This could be attributed to unfair interactions offered by a lecture method on gender. This results obtained, however, is in sharp contrast with the results of Ibe (2004) and Ghumdia (2016) who found no significant difference between males and females in the lecture method of teaching.

3.1 Educational implications

This study has shown the need to incorporate the use of inquiry-based approach to the teaching and learning process of general chemistry at the Colleges of Education, as it provides problem-solving abilities to student-teachers which gives prompt understanding and assimilation of concepts.

Again, inquiry based approach, offers students more hands-on activities, with the teacher acting as a facilitator. In the process of investigation, through observation, questioning, experimentation, drawing conclusions, etc. the student-teachers, find the truth and acquire knowledge by himself without necessary told. There is therefore, the need to pay special attention to the approaches to teaching during instructional periods in chemistry in general, to foster problem solving abilities in students.

4.0 CONCLUSION

An inquiry-based method of teaching produced a significant better performance in an experimental group than control group counterpart taught by lecture method in general chemistry. Hence, inquiry-based method of teaching promotes understanding of general chemistry concepts and enhances student-teachers' performance. In the use of inquiry method of teaching, gender is not a significant factor on students-teachers' performance, since no statistically significant difference was found between male and female student-teachers' performance in general chemistry. Lecture method, on the other hand, produced a significant difference between male and female student-teachers' performance in general chemistry.

4.1 RECOMMENDATIONS

Based on the findings of this study, the researcher recommends that:

1. Inquiry method of teaching should be in-cooperated in the teaching and learning of chemistry, since the method has proved effective in enhancing students' academic performance in general chemistry.
2. In the inquiry method of teaching students must be provided with more hands-on activities to enable them discover facts and build on their pre-exiting knowledge.
3. Teachers who resort to the use of lecture method must cater for both sexes equally.

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