

Impact of Conceptual Instructional Method on Students' Academic Achievement in Practical Chemistry among Secondary School Students in Zaria Educational Zone Kaduna State Nigeria

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Abstract

The study investigated the Impact of Conceptual Instructional Method on Students' Academic Achievement in Practical Chemistry. The population for the study was 1401 S.S. II Science Students. A sample of 100 Students was randomly drawn from two co-educational secondary schools. The subjects were divided in to two: Experimental and control groups of 50 students each. Pretest-posttest quasi-experimental control group design was adapted. The subjects in the experimental group were exposed to Conceptual Instructional Method, while those in the Control group were exposed to lecture method for a period of six weeks. The instrument developed for data collection was: Chemistry Practical Achievement Test (CPAT) with reliability coefficient of 0.71, two research questions were stated and two null hypotheses were tested. The data collected were subjected to statistical analysis at 0.05 level of significance. *t*-test statistics was used. The findings from the study are: Academic Achievement of Subjects Exposed to Conceptual Instructional Method was significantly higher than their counterparts exposed to lecture method of instruction. With reference to gender, there was no significant difference between male and female students academic achievement in the experimental group. On the basis of the findings, it was concluded that, conceptual instructional method enhances students' academic achievement towards practical chemistry. Amongst the recommendations made include: Chemistry teachers should incorporate conceptual instructional method for teaching at senior secondary school level.

Keywords: Conceptual instruction, Practical Chemistry, Academic-Achievement, Students & Gender

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1.0 Introduction

Science educators have been advocating the need for science instruction at all levels to focus on enhancing students conceptual understanding, higher levels of performance in scientific thinking, reasoning and problem solving (Chin & Chia, 2005). This advocacy is inconsistent with various reform initiatives around the globe, for both science and mathematics curricula and classroom practices. For instance, the need to develop students' conceptual understanding and scientific literacy by using inquiry and problem-solving experiences and skills acquisition has been emphasized in the United States reform documents of the American Association for the Advancement of Science (AAAS, 2008).

The role of chemistry in the development of the scientific base of a country cannot be over emphasized and Nigeria is not an exception (Oloyede, 2010). Chemistry is one of the Science subjects taught at the senior secondary school level. It is one of the core science subjects that students are required to pass in order to qualify for admission into tertiary institutions to pursue science-based programmes e.g Medicines, Engineering, Pharmacy among others (Njoku, 2007).

Chemistry is an experimental science which relies primarily on the harmony between theory and practical. It should therefore be taught as such. It follows therefore that, understanding of concept in practical chemistry will assist in enhancing student's understanding of chemistry (Ikeobi, 2010). Students have difficulty in making connections between the sub-disciplines of chemistry (which tend to be taught separately); the link between practical work and theory is often less than obvious; not enough emphasis is given to understanding of concepts in practical chemistry (Cole; Janes; Mclean & Nicholas, 1998).

In chemistry teaching, the importance of harmonizing practical work with theory cannot be over-emphasized. Omolade (2008) states that; if the academic achievement of students is to be enhanced, learners must have deep understanding of basic concepts behind practical task they engage in. This is because the observations and experiments students carry out are meant to confirm some theories and the application of concepts.

In spite of this important position of chemistry among other science and science related disciplines, students' academic achievement has consistently been below expectation and unimpressive (Jegede, 2010; Oloyede, 2010).

Activities by professional bodies like Science Teachers Association of Nigeria (STAN) and Nigerian Educational Research and Development Council (NERDC) for the past two decades are aimed at stimulating interest in science at all levels of education. Aspects that have been looked into include curriculum modification, innovation, teaching methods, teaching facilities, students' factors. Perhaps one of the factors that has not received much attention is the role of conceptual instruction in popularizing science (Jegade, 2010). In spite of the emphasis and attempts at the modification of curriculum, the desired level of improvement remains an illusion.

Conceptual knowledge is the knowledge rich in relationships and understanding. It is a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete bits of information. Conceptual knowledge cannot be gained by rote learning. It must be learnt by thoughtful, reflective learning (Rittle, 2009). Ibrahim, Erdal and Mustapha (2009) states that; Conceptual instructional method is a process of acquiring a better understanding of concepts. The paper is aimed at investigating students' academic achievement and gender difference in practical chemistry.

The influence of gender on students' academic achievement has for a long time been of concern to many researchers but no consistent result has been established. For instance, Inyang and Jegede (1991), Aluko (2005) reported that gender has no effect on students achievement in science. Shaibu and Mari (1997) explained that female subjects were significantly better than their male counterparts and that there was a significant difference between the male and female subjects in their ability to solve quantitative problems. Some instructional strategies are gender bias while some are gender friendly; however, the degree of gender related differences in learning vary from one method of instruction to the other. Therefore the effects of conceptual instructional method on students' academic achievement and gender difference were examined.

2.0 Research Questions

This study seeks to answer the following research questions:

- 1). What is the difference in academic achievement of subjects taught practical chemistry concepts using conceptual instructional method and those taught the same concepts using the lecture method at senior secondary school level?
- 2). Is there any difference in academic achievement between male and female subjects taught practical chemistry concepts using conceptual instructional method at senior secondary school level?

3.0 Null Hypotheses

Ho₁: There is no significant difference in academic achievement between subjects taught practical chemistry concepts using conceptual instructional method and those taught same concepts using lecture method at senior secondary school level.

Ho₂: Male and female subjects do not differ significantly in academic achievement after exposure to practical chemistry using conceptual instructional method at senior secondary school level.

4.0 Methodology

A pretest, posttest, quasi-experimental/control groups design is used. Two groups of students participated in the study, the Experimental and Control groups. The population of the study comprises of SSII science students in the 17 public senior secondary schools that offer chemistry in Zaria Educational Zone of Kaduna State. The population comprises of single sex and co-educational schools. There are four male Schools, four female Schools and nine co-educational schools in the population. The total number of students in the population are 1401, comprising of 865 males and 536 females.

One hundred students served as sample for the study. Since gender is one of the variables in the research, purposive sampling procedure was adopted to ensure subjects chosen that is both male and female had similar background, experience and environmental exposure. Therefore only the nine (9) co-educational schools were chosen out of seventeen (17) schools in the population. The co-educational schools comprises of 684 students out of which 416 are males while 268 are females.

The nine schools chosen were pretested and ANOVA statistical tool was used to analyse the data. Two schools that do not differ significantly were chosen randomly and are assigned as experimental and control centres. 20% of students from the sample in each school were used for the study which is in accordance with the central limit theorem by Tuckman (1975) who recommended a minimum of 30 subjects as sample for experimental research. The instrument used for data collection was Chemistry Practical Achievement Test (CPAT) with reliability coefficient of 0.71 which was submitted to experts for content as well as face validation. Before the commencement of the treatment, a pretest was administered to the two groups in order to determine the equivalence of the groups in ability.

The experimental group were taught the concepts in Practical Chemistry using Tennyson and Cocchiarella model (1986) of concept teaching, while the control group were taught the same concepts using the lecture method. At the end of the treatment period, a posttest was administered to both groups of students in order to evaluate the effectiveness or otherwise of the treatment for enhancing the learning of practical chemistry concepts among SS II students. The results and responses of the subjects obtained from the research instrument (CPAT), was scored using the marking guide developed by the researcher and the data collected was analyzed using *t*-test statistical tool at probability $P \leq 0.05$ level of significance for retaining or rejecting the null hypotheses.

5.0 Results

Table 5.1: Comparison of the Academic Achievement Posttest mean Scores of the Subjects in the Experimental and Control Groups

Groups		S.D	S.E	df	<i>t</i> -value	<i>p</i> -value	Remarks	
Experimental	50	33.06	8.610	1.218	98	2.775	0.008	Significant
Control	0	27.90	8.617	1.219				

Significant at $p \leq 0.05$

The data in Table 1.1 shows that, the p -value obtained is 0.008 at $p \leq 0.05$ level of significant. The p -value of 0.008 obtained is thus significant as it is less than 0.05 level of significance set for the research. The null hypothesis of no significant difference is thus rejected. This means that there is significant difference in the academic achievement of the subjects in experimental and control groups.

The result thus shows that; the conceptual instructional method seems to be more effective in improving students' academic achievement in the chemistry practical concepts than the lecture instructional method. It implies that, the subjects taught using conceptual instructional method achieved significantly better than those taught using the lecture method of instruction furthermore, the mean score value of 33.06 for experimental group and 27.90 for the control group further confirms this. Therefore the null hypothesis is thus rejected.

Table 5.2: Comparison of the Academic Achievement Posttest Mean Scores of Male and Female Subjects in the Experimental Group

Groups	Gender		\bar{X}	S.D	S.E	df	t -value	p -value	Remarks
Experimental	Male	25	31.00	7.605	1.521	48	1.727	0.097	Not Significant
	Female	25	30.36	9.242	1.848				

Not significant at $p \leq 0.05$

The data in Table 1.2 shows the results of posttest scores for male and female subjects in experimental group and the p -value obtained is 0.097 which is greater than 0.05 p -level of significant at df of 48. Thus the null hypothesis is therefore retained. This indicates that; there is no significant difference in the achievement scores of male and female subjects when taught practical chemistry concepts using conceptual instructional method.

The result also shows that the mean achievement score of male subject is 31.00 while the mean achievement scores of female subject is 30.36 which implies that the conceptual instructional method has not brought any significant difference in the achievement of male and female subjects in practical chemistry.

This therefore means that the conceptual instructional method which was used for instruction with the experimental group is gender-friendly, since both gender equally benefit from the method thus the null hypothesis of no significant difference is retained.

6.0 Discussion

The result in Table 5.1 shows a significant difference in the post-test achievement mean scores of the experimental and control groups. The experimental groups achieved significantly higher than the control group. This finding is in line with that of Clark (2003) in a similar study which indicated students exposed to conceptual instructional approach achieved better than their counter parts. The superiority of conceptual instructional method over the lecture method was also reported by Jordi (2010) who conducted a research on the development of conceptual instruction and traditional instruction in chemistry and find that; those taught with conceptual instructional method performed better than those taught using the traditional method of instruction.

A contrary result was obtained by Douglas (1997) in his research on the effect of explicit problem-solving and conceptual instruction in physics. The result indicated that, there was no overall difference between the two groups.

In this research, the significant difference in favour of the experimental group suggests a greater effectiveness of the conceptual instructional method which was used to teach the subjects in the experimental group due to the fact that, concepts are linked with prior knowledge which makes them more meaningful and more embracing. The superior success of the subjects in the experimental group over their counterparts in the control group could be explained by the fact that, conceptual instructional method enhances the understanding of concepts in practical chemistry as suggested by (Tennyson & Chocchiarella, 1986).

Hypothesis two was stated to find out whether there is significant difference in academic achievement of male and female subjects taught practical chemistry concepts using conceptual instructional method. Findings from the study as shown in Table 5.2 indicate that; the male and female subjects in experimental group showed no significant difference in achievement.

This means that there is no significant difference in the academic achievement of male and female subjects taught chemistry practical concepts using conceptual instructional method.

Therefore this means that; conceptual instructional method used and the achievement of the subjects is gender friendly. The result is in support of the findings of Ogunboyede (2003) who conducted a research comparing the academic achievement of boys and girls at primary school level. The findings indicated that; boys are not better than girls in terms of educational achievement. Also a research conducted by Okeke (2001) on the influence of cognitive style, cognitive level and gender on students' achievement in physics did not find either gender performing better.

In this research there is no difference in academic achievement in male and female subjects due to the fact that, they are both exposed to same concepts, under the same condition by same teacher using the same method of instruction, therefore conceptual instructional method is gender friendly. Less emphasis on gender and gender-bias treatment of male and female seems to be bridging the gender gap in learning between male and female.

7.0 Conclusions

Based on the findings from this study, the following conclusions are drawn:

Conceptual instructional method enhances academic achievement of senior secondary school students towards practical chemistry. Therefore conceptual instructional method is viable and has potential to enhance senior secondary school students' academic achievement in chemistry. The teaching of practical chemistry, using conceptual instructional method, was found to be gender friendly. This means that, both male and female students equally benefit in conceptual instructional strategy.

8.0 Recommendations

On the basis of the findings and conclusions reached, the following recommendations are made:

1. This study shows that, conceptual instructional method enhanced students' academic achievement, practical and attitude towards practical chemistry compared to lecture method. Use of conceptual instructional method by chemistry teachers should therefore be encouraged in Nigerian secondary schools.
2. It is recommended that teacher training colleges, universities and educational institutions should incorporate conceptual instructional method in their curricular at all levels.
3. Professional associations like; the Science Teachers Association of Nigeria (STAN), Chemical Society of Nigeria (CSN) and Research Centres such as Nigerian Educational and Research Development Council (NERDC), should incorporate conceptual instructional method in their science curricular at senior secondary school level.
4. Since the strategy is gender friendly, it could serve as effective instructional strategy in both single sex and co-educational schools.

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