African Educational Research Journal
Vol. 3(3), pp. 184-189, August 2015
ISSN: 2354-2160
Full Length Research Paper

Effect of prior knowledge and classroom interactions on students' achievement in chemistry

Fatokun K. V. F.[1]* and Omenesa K. A.[2]

[1]Department Science, Technology and Mathematics Education, Nasarawa State University, Keffi, Nigeria.
[2]Department of Science Education, Federal University Dutsin-ma, Katsina State, Nigeria.

Accepted 20 August, 2015

ABSTRACT

This study was undertaken to determine the effect of prior knowledge and classroom interaction on students' achievement in chemistry. Two schools were purposively sampled and quasi experimental design was adopted. The sample consists of 93 senior secondary II students from two schools in Dutsin-Ma, Katsina State, Nigeria. A 20 – item Chemistry Achievement Test (CAT) and a Prior Knowledge Questionnaire (PKQ) were administered on the students to generate data for analysis. The reliability index obtained for CAT and PKQ using Kuder-Richardson method (KR-21) were 0.72 and 0.75, respectively. The test items span all the intellectual levels of the cognitive domain. Three null hypotheses were tested at α = 0.05 level of significance. Results revealed that there is significant effect of treatment on students' achievement in chemistry. However, interaction effect of treatment and gender on students' achievement in chemistry is not significant. It is also indicated that there is no significant mean difference in prior knowledge of the experimental group and the control group. Teachers should ensure that chemistry is taught with enriched classroom interaction to enhance appreciable achievement in chemistry learning.

Keywords: Prior knowledge, classroom interaction, chemistry achievement.

*Corresponding author. E-mail: victfatokun@yahoo.com.

INTRODUCTION

Chemistry is concerned with the utilization of natural substances and the creation of artificial ones (Ojokuku, 2010). Prior knowledge according to Dochy and Alexander (1995) is the whole of a person's knowledge, including explicit and tacit knowledge, metacognitive and conceptual knowledge. This definition is quite similar to Schallert's (1982). Prior knowledge and background knowledge are themselves parent terms for many more specific knowledge dimensions such as conceptual knowledge and metacognitive knowledge. Subject matter knowledge, strategy knowledge, personal knowledge, and self-knowledge are all specialized forms of prior knowledge/background knowledge.

Prior knowledge enhances learning as it is essential to the attainment of stated instructional objectives. It is the existing knowledge structure on which a student key in new idea learnt. Most students consider the different concepts as isolated elements of knowledge because they do not possess a well founded basic framework in which newly acquired concepts can be integrated (Fatokun, 2012b).

Anthony (2009) reported that the understanding of balancing of chemical equation is a prerequisite to the comprehension of some learning tasks in chemistry such as chemical equilibrium, electrochemistry and organic chemistry. Balancing chemical equations also is one of the difficult chemical concepts students encounter in both practical and theory. WAEC chief examiners' reports of 2009, 2010, and 2011 ascertained that most chemistry students perform poorly in chemistry because of their inability to write correctly, the reactants, the products as well as to balance the reaction equation correctly.

Piaget's and Vygotsky's cognitive development theories have similar foundations; they believe that children are active learners in their environment. They both also believe that cognitive development takes place over time and that new information is built on prior knowledge. Vygotsky proposes that cognitive development is strongly

linked to input from others, he lays emphasis on the socio-cultural nature of learning (Karpov and Haywood, 1998). He believes that learning takes place when the learners are working within the zone of proximal development. Tasks within the zone of proximal development are ones that a child has not yet done alone but they could do with the assistance of more competent peers or adults. Vygotsky further believes that higher mental functioning usually exists in conversation and collaboration among individuals before it exists within the individual. These two theories form the basis of this study.

Classroom interaction is an interpersonal relationship either between students or between the teacher and the students, and it occurs at different levels. Audu and Achor (2003) stated that interaction in the classroom involves an active encounter of the teacher and the students through verbal, gestural and resource instrumentality to bring about effective communication in a teaching/ learning process. Teacher- student interaction in the classroom is a two-way process because each participant influences the other's behavior, that is, the student's condition their teacher's behavior and vice versa (Inamullah, 2005). The teacher and fellow students both play a role in influencing student achievement since this relationship is an essential part of teaching and learning process. Students must learn to interact respectfully, but must also learn how to be assertive without being rude, so that their opinions are heard without disruption. Improving students' relationships with teachers has important, positive and long-lasting implications for students' academic and social development. Students with close, positive and supportive relationships with their teachers will likely attain higher than those students with more conflicting relationships.

Positive teacher-student relationships affect students' performance in chemistry because it promotes their interest in learning (Fatokun, 2012a). Burns (1999) equally observes and confirms that chemistry teachers need to help their students to overcome their fears, approach chemistry with confidence, develop problem solving skills and apply principles of chemistry when solving problems by understanding that chemistry is a part of everyday life. A good classroom interaction coupled with a well defined cognitive framework will enhance retention of concept learnt and recall of such ideas when needed.

Yusuf (2014) investigated the effects of collaborative learning on chemistry students' academic achievement and anxiety level in balancing chemical equations in secondary schools in Katsina metropolis, Nigeria. The findings from the study showed those students taught using collaborative learning achieved significantly higher and their anxiety was found to be lower when compared with those taught using lecture method.

There has been contrasting opinions on gender related issues in interaction. Onyegegbu (2004) in a research reported that girls participated in fewer interactions than boys. Fatokun and Odagboyi (2010) viewed gender as a significant factor in students' achievement in chemistry due to interaction patterns. Fatoba and Aladejana (2014) stated that gender was found to have no effect on students' attitude to learning while Olasheinde and Olatoye (2014) findings showed that there was no significant difference between male and female students in overall science achievement in Katsina State. In most science-related fields there tend to be more males than females as Baker and Maclyntyre (2003) carried out experiment at Georgia Elementary Schools and concluded that both boys and girls showed significant difference in science and other subjects between the ages of 13 to 14 years when they were younger and that as they grew, their interest reduced.

Despite the relative and increasing importance of chemistry to the whole world, students' performance in chemistry at Senior Secondary Certificate Examination (SSCE) has been reported to be a dismal failure (Saage, 2009). This failure is linked to the student related factor, teacher factor, societal factor, the government, infrastructure (Korau, 2009). Saage (2009) identified specific variables such as poor primary school background in science, lack of interest on the part of the student, incompetent teachers, phobia or apprehension that chemistry is difficult etc. Other factors advanced as contributing to students' poor performance in chemistry include poor student-teacher interaction and lack of prior knowledge of some basic chemical concepts. Reports have shown poor performance of students in science subjects in the northern part of Nigeria (Table 1).

This study is experimenting on the effect of prior knowledge and classroom interaction on students' achievement in chemistry among senior secondary school in Dutsin-Ma Local Government Area, Katsina State. It involves the teacher and the students working together in order to improve some student cognition in selected content area in chemistry.

Purpose of the study

The main purpose of the study was to determine the following:

1. The mean prior knowledge of students in some selected chemical concepts and it effect on their achievement.
2. The effect of student-teacher interaction on students' achievement in chemistry.
3. Difference in chemistry students' achievement by gender.

Research questions

The following research questions were investigated in

Table 1. Performance of students in chemistry at SSCE level (WAEC) in Katsina State from 2009 to 2013.

Year	No. of students present	No. of students pass	No. of students fail	% pass	% fail
2009	1800	355	1445	23	80
2010	1905	340	1565	18	82
2011	2033	400	1629	20	80
2012	2210	401	1809	18	82
2013	2560	528	2032	21	79

Source: Katsina State Ministry of Education (2013).

this study:

1. What is the mean prior knowledge of students in chemistry?
2. What is the effect of student-teacher interaction on students' achievement in chemistry?
3. Is there any effect of gender on students' achievement in chemistry?

Hypotheses

HO_1: There is no significant mean difference of students' prior knowledge in chemistry.
HO_2: There is no significant effect of student-teacher interaction on students' achievement in chemistry
HO_3: There is no significant effect of gender on students' achievement in chemistry.

METHODOLOGY

The study utilized the pretest - posttest quasi- experimental design (Oloyede, 2007).

Population

All Senior Secondary School two (SSS II) chemistry students in Dutsin-ma L. G. A. Katsina State of Nigeria constitute the population for this study.

Sample and sampling techniques

Two coeducational secondary schools were purposively sampled and the study subject consist of 93 (8 female and 28 male formed the experimental group from one of the schools while 44 male and 13 female are in the control group from the other school) SSII chemistry students from an intact class in each of the two selected schools. Students' previous academic performances were averagely the same when compared from existing records and similar facilities were also available in the two selected schools.

Instrumentation

Two major instruments apart from the instructional guide and lesson plan for both the experimental and control groups respectively were developed by the researchers. These instruments were Chemistry Achievement Test (CAT) and Prior Knowledge Questionnaire (PKQ). The teacher made CAT was 20 selected objective items of SSCE type drawn from specific content area in chemistry (Water, Solution, Solubility, etc) to determine the effect of the treatment on experimental group. PKQ was a 15 items four- point Likert type scale. It was used to determine the subject's prior knowledge in the selected chemical concept for the study. The instruments were earlier subjected to face and content validity before field testing. CAT reliability index was calculated using Kuder-Richardson method (KR-21) as 0.72 and PKQ reliability index was 0.75.

Design

A pre-test post–test quasi–experimental design was adopted for the study.

Procedure

A pre test and PKQ was administered on the two groups. This was to determine the entry behavior of the students in terms of what they already know about what is to be taught. Thereafter, a class of 57 students was taught the selected topics for four weeks using demonstration method (control group) and the other class of 36 students (experimental group) was also taught the same selected topics for four weeks simultaneously using the student-teacher interaction approach (highly interactive classroom setting).

RESULTS

Research question 1: What is the mean prior knowledge of students in chemistry? Data related to this question are presented in Table 2.

Table 2 shows the mean and standard deviation of both the experimental and control group. The experimental group has a prior knowledge mean difference above the control group which implies that the experimental group has more prior knowledge of chemistry than the control group.

Research question 2: What is the effect of student-teacher interaction on students' achievement in chemistry?

Table 3 shows the pre-test and post-test mean scores of both the experimental and control group. In the pre-test the control group performed better than the experimental

Table 2. Mean and standard deviation of students' prior knowledge in chemistry.

Group	Mean	N	Std. deviation	Mean difference (I-J)
Experimental (I)	36.1944	36	3.38754	0.17032
Control (J)	34.4912	57	3.74224	
Total	35.1505	93	3.68589	

Table 3. Mean and standard deviation of students' achievement in chemistry.

Group	Pre-test			Post-test		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Experimental group (I)	36	4.6667	1.86701	36	7.5556	2.59058
Control group (J)	57	5.0877	1.50334	57	4.9649	1.78250
Total	93	4.9247	1.65658	93	5.9677	2.46916
Mean diff. (I-J)		-0.421			2.5907	

Table 4. Comparison of male and female students' achievement in chemistry (experimental group).

Experimental	Gender	N	$\bar{X}$	SD	Standard error of mean
Pre-test	Female	8	5.4857	1.50238	0.25395
	Male	28	4.5862	1.66527	0.21866
Total		36	4.9247	1.65658	0.17178
Mean difference			0.8995		
Post-test	Female	8	5.3714	1.49678	0.25300
	Male	28	6.3276	2.85551	0.37495
Total		36	5.9677	2.46916	0.25604
Mean difference			-0.9565		

group but in the post-test the experimental group performed better than the control group.

Research question 3: Is there any effect of gender on students' achievement in chemistry?

Table 4 shows the mean score of the female students in the pre-test and post-test and that of the male students. Chemistry achievement mean score of female students is higher than the mean score of their male counterparts in the pre-test while in the post-test the male chemistry achievement mean score is greater than their female counterparts. Though the sample size of the female is smaller than the male, the value is still comparable and the result valid since intact class was used.

Hypotheses testing

HO_1: There is no significant mean difference of students, prior knowledge in chemistry.

Table 5 shows that $F_{15,91}$= 0.824 is greater than p > 0.05. This shows that, there is no significant mean difference in the prior knowledge between the experimental and control group.

HO_2: There is no significant effect of student-teacher interaction on students' achievement in chemistry

Table 5 shows that $F_{1,91}$ = 0.035 is less than p < 0.05. This means that there is a significant difference between the experimental and control group and the difference is in favour of the experimental group. This means that those students taught using student-teacher interaction tend to achieve significantly higher than those taught using demonstration method. Therefore the hypothesis is rejected.

HO_3: There is no significant effect of gender on students' achievement in chemistry.

Table 4 shows that $F_{1,91}$=0.127 is greater than p > 0.05. This means that there is no significant difference between the male and female students in the experimental group. This means that students tend to achieve irrespective of

Table 5. Analysis of covariance (ANCOVA) of students' overall achievement scores due to student-teacher interaction, prior knowledge and gender.

Source	Type III sum of squares	df	Mean score	f	Significance
Corrected model	243.349	42	5.794	1.285	0.200
Intercept	99.216	1	99.216	22.000	0.000
Pre-test	1.047	1	1.047	0.232	0.632
Treatment	21.182	1	21.182	4.697	0.035
Gender	0.367	1	0.367	0.081	0.777
PK	43.495	15	2.900	0.643	0.824
Treatment*gender	10.889	1	10.889	2.414	0.127
Treatment*PK	41.507	8	5.188	1.150	0.348
Gender*PK	18.881	10	1.888	0.419	0.931
Treatment*gender*PK	11.015	4	2.754	0.611	0.657
Error	216.475	48	4.510		
Total	3535.000	91			
Corrected total	459.824	90			

their gender.

DISCUSSION

Table 5 shows that there is no significant mean difference in the prior knowledge of both the experimental and control groups. This result is in line with Fatokun (2012b) and Demide (2011). Students taught using student-teacher interaction tend to achieve significantly higher than those taught using demonstration method. The finding is in agreement with Yusuf (2014) and Olatoye et al. (2010) who, in their study, revealed that students taught using collaborative and cooperative learning achieve significantly higher when compared with those taught using other method.

Table 5 also shows that there is no significant difference between male and female students achievement. This means that students tend to achieve irrespective of their gender. This result contradicts Onyegegbu (2004) who reported that girls participated in fewer interactions and achieve lower than boys. But this result is consistent with Olasheinde and Olatoye (2014) findings which showed that there were no significant difference between male and female students in overall science achievement in Katsina State and is also in line with Adekoya and Olatoye (2011) who found no significant interaction effect between treatment and gender when two strategies were employed to teach science to different groups of students.

Conclusion

Based on the fact that there was a difference in the achievement of the two groups in favour of the experimental study, it is evident that there is positive effect of interaction on the performance of students in chemistry which is likely to be the product of their changed attitude and developed interest in the subject.

The implication of this study is that teachers should ensure that chemistry is taught with high level of classroom interaction to boost students' interest and enhance their understanding of content learnt which invariably lead to greater achievement. Also teachers should assist the students to discover and link their pre-existing knowledge in teaching and learning process, this will help students understand science concepts. Teachers should ensure and encourage male and female students participate equally and actively during the classroom instructions.

Further researches are suggested to be carried out on the effect of classroom interaction on students' attitude, interest and achievement in chemistry and enhancing student's metacognition through their prior knowledge inference.

REFERENCES

Adekoya, Y. M., and **Olatoye**, R. A. (**2011**). Effect of demonstration, peer-tutoring, and lecture teaching strategies on senior secondary school students' achievement in an aspect of agricultural science. Pacific Journal of Science and Technology, 12(1):320-332.

Audu, T. A., and **Achor**, E. E (**2003**). The role of questioning and wait-time interactional processes in science teaching and learning. Journal of Science and Vocational Education, 2(2):53-56.

Baker, S. C., and **Maclyntyre**, P. D. (**2003**). The role of gender and immersion in communication and second language orientations. In Dornyei, Z. (Ed.) Attitudes, Orientation and Motivation Language Learning. Wiley-Blackwell.

Burns, R. A. (**1999**). Fundamentals of Chemistry. New Jersey; Prentice hall Inc

Demide, C. O. (**2011**). Effect of prior knowledge on students' cognition, comprehension and achievement in some content area in chemistry. An unpublished Ph. D thesis of ATBU, Bauchi.

Dochy, F. J. R. C., and **Alexander**, P. A. (**1995**). Mapping prior knowledge: a framework for discussion among researchers. European Journal of Psychology of Education, 10(3):225-242.

Fatoba, J. O., and **Aladejana**, A. L. (**2014**). Effects of gender on

students' attitude to physics In secondary schools in Oyo state, Nigeria. European Scientific Journal, 10(7):399-404.

Fatokun, K. V. F (**2012a**). Attitude as a correlate of achievement in chemistry among secondary school students in Nasarawa State. Benue State University, Journal of Education, 12:57-62.

Fatokun, K. V. F. (**2012b**). The Effect of Concept Mapping-Guided Discovery Integrated Teaching Approach on Chemistry Students' Learning Style, Achievement and Retention. Unpublished Ph.D Thesis Nasarawa State University, Keffi.

Fatokun, K. V. F., and **Odagboyi**, I. A. (**2010**). Gender disparity and parental influence on secondary school student's achievement in Nasarawa State. Journal of Research in National Development, 8(2a):8–12.

Inamullah, M. (**2005**). Patterns of classroom interaction at different educational levels in the light of Flander's Interaction. Unpublished Ph.D Thesis. Nsukka: University of Nigeria.

Karpov, Y. V., and **Haywood**, H. C. (**1998**). Two ways to elaborate Vygotsky's concept of mediation. American Psychologists, 53(1):27-36.

Korau, Y. K. (**2009**). Educational crises facing Nigerian secondary schools and possible solutions. A paper presented at the Faculty of Education, University of Ibadan.

Ojokuku, G. O. (**2010**). Understanding Chemistry for Senior Secondary School. Zaria: Press-on chembooks

Olasheinde, K. J., and **Olatoye**, R. A. (**2014**). Comparison of male and female senior secondary school students' learning outcomes in science in Katsina State, Nigeria. Mediterranean Journal of Social Sciences, 5(2):518–523.

Olatoye, R. A, Aderoga, A. A., and Aanu, E. M. (**2010**). Effect of cooperative and individualized teaching methods on senior secondary school students' achievement in organic chemistry. Pacific Journal of Science and Technology, 12(2):310-319.

Oloyede, O. I. (**2007**). Educational Measurement and Evaluation for tertiary institutions, an introduction. Kaduna: Euneeks and Associates

Onyegegbu, N. (**2004**). Interaction and gender in senior secondary school science classroom. Journal of the Nigerian Academy of Education, 2(1):33-41.

Saage, O. (**2009**). Causes of mass failure in mathematics examination among student. A commissioned paper presented at Government Secondary School, science day, Karu Abuja. 1st March, 2009.

Schallert, D. L. (**1982**). The significance of knowledge: a synthesis of research related to schema theory. In W. Otto, & S. White (Eds.), Reading expository prose (pp. 13-48). New York: Academic.

Yusuf, S. D. (**2014**). Effect of collaborative learning on chemistry students' achievement and anxiety level in balancing chemical equations in secondary schools in Katsina Metropolis, Nigeria. Journal of Educational and Vocational Research, 5(2):43-48.

Citation: Fatokun, K. V. F., and Omenesa, K. A. (2015). Effect of prior knowledge and classroom interactions on students' achievement in chemistry. Afr Edu Res J, 3(3): 184-189.