EFFECTS OF COGNITIVE REASONING ABILITY AND PRIOR EXPOSURE TO CONTENT ON BASIC SCIENCE ACHIEVEMENT OF UPPER BASIC TWO STUDENTS IN PLATEAU STATE

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Abstract

Worried by the poor achievement of students and search for appropriate strategy and the possible influence of students' reasoning ability, the study addressed the effects of cognitive reasoning ability and prior exposure to content on Upper Basic two students' achievement in Basic Science. The study utilized a pre-test post-test quasi-experimental design; it was a non equivalent control group type. The population is all the Upper Basic II students which is 14469 with a sample of 400 students selected using both purposive and random sampling techniques. The instruments that were used to collect data were Basic Science Achievement Test (BSAT) and Science Reasoning Tasks (SRT). The reliability of BSAT was determined using the Kuder Richardson 21(K-R_{21}) formula and found to be 0.89 while that of SRT II using test retest approach was found to be 0.81. It was found that prior exposure of students to content of basic science significantly improved achievement. Similarly, achievement of high and low reasoning ability level students significantly differed in favour of high ability students. The study also found that male and female basic science students exposed to content prior to instruction do not significantly differ in their achievement. It was recommended that Basic science teachers should be made to be aware of the relationship that exists between reasoning pattern of learners, conceptual demand of the school subject and the methods of teaching that will facilitate good performance, among others.

Keywords: Basic education; prior exposure to content; basic science; cognitive reasoning; achievement in basic science; gender

Introduction

Science and technology have greatly contributed to the convenience and comfort of man. The usefulness and relevance of science and technology to sustainable development is therefore not in doubt. No one is in doubt in this 21st century that every facet of man's endeavour has been largely affected by science and technology in diverse proportions and dimensions. Hardly is there any sphere of life that is not affected by the development in science and technology. Man's present existence on the globe is highly predicated upon his knowledge and applications of scientific knowledge, principles and technological breakthrough. It is in recognition of this that science was introduced into the Nigerian school curriculum. Basic Science (formally called integrated science) in particular was introduced as the basic foundation to the other sciences at the Upper Basic level (that is, 7^{th}, 8^{th} and 9^{th} grades).

Basic science is a course that integrates students into the world of science after being exposed to the rudiment of science called, primary science at the primary school level (Odetoyinbo, 2004; Emeka & Odetoyinbo, 2003). One of the objectives of integrated science is to serve as a foundation for further study of science at higher level or bedrock for scientific literacy. This adds credence to the importance of integrated science. However the logical question to ask is, since these objectives were written more than two decades ago, has integrated science been able to achieve these? These objectives can only be achieved if students understand very well the integrated science contents taught at the Junior Secondary School (JSS) level. The new curriculum of Basic Science is almost the same with the old integrated science curriculum, except for the following new themes that were infused into it:

(i) Environmental education
(ii) Drug abuse education
(iii) Population and family life education
(iv) Sexually transmitted infection (STI) including HIV/AIDS (FGN, 2006).

Details of the differences between integrated and basic science are contained in Table 1.

Table 1: The objectives of integrated science and basic science curricula of junior secondary school compared

Objective	Integrated science	Basic science
Why the curriculum	Adoption of 6334 system	Continuation of 6334 system and the introduction of the universal basic education
Source of the curriculum	Global shift in science technology	Millennium development goals (MDG's) and national economic empowerment and development strategies (NEEDS)
Basic objectives of the curriculum	Observing carefully and thoroughly. Reporting completely and accurately what is observed. Organizing information acquired Generalizing on the basis of acquired information Predicting as a result of the generalization Designing experiments (including controls where necessary to check prediction). Using models to explain phenomena where appropriate Continuing the process of inquiring when new data do not conform to predictions	Develop interest in science and technology Acquire basic knowledge and skills in science and technology Apply their scientific and technological knowledge and skills to meet societal needs. Take advantage of the numerous opportunities offered by science and technology Become prepared for further studies in science and technology
Structure	Thematic	Thematic
Philosophical foundation	The child is scientific and should be exposed to science activity	The child should be made to develop self and society
Psychology foundation	Involve discovery learning problem solving, open ended and open laboratory exercise	Use of guided inquiring method of teaching and learning
Sociological foundation	The prevailing socio economic factors in Nigeria	Globalization information/communication technology and entrepreneurship

Source: Dung and Nsikak-Abasi in Duguryil (2012)

The overall objectives of Basic science curriculum are to enable learners to:
(i) Develop interest in science and technology
(ii) Acquire basic knowledge and skills in science and technology
(iii) Apply their scientific and technological knowledge an skills to meet societal needs
(iv) Take advantage of the numerous career opportunities offered by science and technology
(v) Become prepared for further studies in science and technology

In order to achieve the stated objectives, the thematic approach to content organisation was adopted. Hence four themes covered knowledge, skills and attitudinal requirements. These are:
(a) You and Environment
(b) Living and non-living things
(c) You and technology
(d) You and Energy

Research reports have revealed that graduates of integrated or basic science leave much to be desired in terms of their achievement in JSSCE examinations (Inyang & Ekpenyong, 2000; Duguryil, 2004; Nwachukwu & Nwosu, 2007). For the past two decades, students' achievement in science subjects are consistently reported to be very poor (Emeka & Odetoyinbo, 2003; Akubuilo, 2004; Ahmed, 2007; Asuafor, 2008). A survey of the JSSCE results of plateau state for five years (2004-2008) revealed that students' performance is also very poor.

For the five years under consideration (2004 to 2008), the percentage pass at distinction level is less than 5% and also the percentage pass at credit level has never exceeded 24% with the exception of 2005 with 52.54% credit pass. This could be a reflection of the fact that the students have not demonstrated the necessary cognitive reasoning skills needed for good performance in their three years of junior secondary school. It could even be that the appropriate teaching strategy was not used or worse still that the students were probably not taught the required integrated science concepts.

Researchers have begun to question the role of cognitive reasoning ability of students in meaningful learning and retention in science subjects. To Achor (2003) the learners' level of cognitive style, thinking and reasoning is a major determinant of achievement. Nkwo, Akinbolola and Edinyang (2008) and Akpan (2007) identified the developmental level of the learner in terms of chronological and cognitive maturity as a major determinant of achievement too. There is, therefore, the need to direct efforts at analysing the reasoning ability of the learners vis-a-vis the instructional strategy that would be appropriate for all ability groups in the classroom by science teachers. Kurtz and Karplus (1979) defined cognitive reasoning ability as cognitive processes by which people start with information and come to conclusions that go beyond that information.

The basic science objectives require that students' reason at the Piagetian formal reasoning level which is usually from 12 years to adolescent. At the period of formal operations, the child's thought process becomes quite systematic and reasonably well integrated. The child reasons (or thinks) formally, logically and understands from one situation to another. This implies that reasoning at this level is at higher order. Whether or not students' reasoning skills are as expected, is an issue that needs to be determined empirically. The consistent poor achievement in basic science could be attributed to lack of appropriate formal operational thought (reasoning) in the students. The question is, what can science teachers do to help students develop formal scientific reasoning ability?

Relationship between instructional methods and the development of scientific reasoning have been widely studied and have shown that inquiry - based science instruction promotes scientific reasoning abilities and students' achievement (Nkwo, Akinbolola & Edinyang, 2008; Martins & Oyebanji, 2000). Students need to develop both content knowledge and transferable reasoning skills. This can only be achieved if a balanced method of teaching is introduced. It is in recognition of this that Ausubel (1968) theorised that prior knowledge of the learners should be a major consideration when planning an instruction. Ausubel further maintained that to take care of the learning needs of the learners, teachers should make use of advance organisers. He described advance organizers as things that the learner can use to stimulate or facilitate learning. In this study prior exposure to content serves as the advance organizer.

Prior knowledge has been identified to be associated with students' achievement in the sciences. For instance, Okebukola (2002) found that knowledge that exists prior to instruction persists despite instructional attempt to change it. This suggests that prior knowledge can be a factor in learning. Other research reports also found achievement to be dependent on prior knowledge of the learners (Orukotan & Balogun, 2000; Arigbabu & Oludipe, 2004). Similarly, Nkwo, Akinbolola and Edinyang (2008) discovered that prior knowledge of objectives significantly affects achievement in the sciences regardless of sex of the learners. The implication of the forgoing is that there must be link between what the learner knows and the new information or content to be learnt. Since prior knowledge of objective has been found to be an asset in science learning, prior knowledge of content could have similar advantages as the objectives are part of the content as specified in the curriculum. The content exposed to students prior to instruction in this case is considered as Ausubel's advance organisers. Sometimes the sex of the learner could be a factor even with the use of prior knowledge of content as advance organizer.

On gender differences in the performance of students in integrated science and the sciences generally, some studies indicated no significant difference between boys and girls (Dimitrov, 1999; Duguryil, 2004; Ogbeba, 2009). These studies found that both sexes equally responded to good instructional strategy. On the other hand, Nkwo, Akubolola and Edinyang (2008) found significant difference in performance of boys and girls in biology when exposed to student centred method. This study therefore investigates effects of cognitive reasoning ability and prior exposure to content on students' achievement in basic science at the Upper Basic two level.

Purpose of the Study

The purpose of this study is to find out effects of cognitive reasoning ability and prior exposure to content on students' achievement in basic science in Plateau State of Nigeria. Specifically this study sets out to:

(i) Determine the effect of exposure to content prior to instruction on Upper Basic II students' achievement in basic science.
(ii) Determine the effect of prior exposure to content on male and female students' achievement in basic science.
(iii) Find out the effect of prior exposure to content on the achievement of high and low reasoning ability students in basic science.

Research Questions

To put this study in focus, the following research questions were answered:

(i) To what extent do students exposed to content prior to instruction and those that were not, differ in their achievement in basic science?
(ii) To what extent do male and female students that were exposed to content prior to instruction differ in their achievement in basic science?
(iii) To what extent do low and high reasoning ability groups with prior exposure to content differ in their achievement in basic science?

Null Hypotheses

The following null hypotheses were tested at 0.05 level:

(i) There is no significant difference in the achievement mean scores of basic science students exposed to content prior to instruction and those that were not.
(ii) There is no significant difference in the achievement mean scores of male and female basic science students exposed to content prior to instruction.
(iii) There is no significant difference in the achievement mean scores of high and low ability basic science students exposed to content prior to instruction.
(iv) Interactions among groups, ability and sex have no significant influence on students' achievement in basic science.

Research Method

Design

The study utilized a pre-test post-test quasi-experimental design. This design was selected due to the fact that random assignment of subjects to treatment groups was not possible. This is because the research was conducted in a school setting and as observed by Achor and Ejigbo (2006), some classrooms situations do not lend themselves to excessive manipulations, therefore intact groups was used. The study was a non equivalent control group quasi-experimental design type.

Population

The population for the study is all the Upper Basic II students in Plateau State central education zone. The population of all the upper basic II students is 14,469 as at 2012. The choice of upper basic II students is based on the fact that the class is not preparing for an external examination at this level. The students are expected to have been exposed to basic science concepts at the upper basic I level to give them a rich knowledge base in terms of reasoning ability. Another consideration for the choice of the class is that at this stage the students are expected to have reached the formal level of reasoning, consequently, they should be able to understand the concepts in their basic science syllabus, most of which require formal reasoning.

Sample

The sample for the study was selected from a population of 14,469 Upper Basic II students distributed among 106 Upper Basic schools in Plateau State Central education zone. A sample size of 418 (20-4 male and 214 female students) was used in the study. Purposive and simple random sampling techniques were employed in the selection of the sample. It is purposive because to ensure precision and control, the researcher selected six comparable schools out of the 106 schools in Plateau central education zone. To do this adequately, the researcher first itemized some factors as the criteria that guided in the selection of the schools. These criteria are: School should be a public school, should be co-educational, should have at least two arms of upper basic II and should operate the National Core Curriculum/ National Examination Council syllabus on basic science. Also the school should have at least one qualified basic science teacher with a minimum of first degree in integrated science, biology, chemistry or physics education and also with a minimum of 3 years post qualification experience, have laboratory facilities, have at least two periods of basic science per week and must have presented students for Junior Secondary School Certificate Examination (JSSCE) for not less than 5years. Based on these criteria, only 78 schools qualified for consideration out of which six were drawn.

The researcher’s decision to use public schools (specifically government owned schools) and not private schools is because the former have in the recent past been affected by rampant strike actions and therefore they may not be comparable with the later in terms of syllabus coverage. Experience also shows that students in government controlled schools are sometimes not placed in the schools on the grounds of their common entrance examinations.

The simple random sampling technique was employed in selecting six secondary schools out of the 78 secondary schools, using the “hat and draw” method. The schools so selected constituted the sample of Upper Basic schools for the study. Simple random sampling method was employed to allocate three schools each to experimental and control groups. Similarly, where there were more than two arms in each of the school, hat and draw technique was applied to obtain any two arms.

Instrumentation

The instruments for data collection were Basic Science Achievement Test (BSAT) and Science Reasoning Tasks (SRT).

Basic Science Achievement Test (BSAT): The Basic Science Achievement Test (BSAT) was used to test students’ achievement in basic science. The test was developed by the researcher based on the concepts that were taught. It contains 50 multiple choice items initially and was reduced to 40 items after validation and item analysis. The multiple choice test was chosen because of its objectivity in marking.

The BSAT covered concepts taught under the following topics; Work, Energy and Power, Simple Machines (Wheel and Axle), Simple Machines (Screw thread), Simple Machines (Gears), Kinetic Theory and Thermal Energy. The BSAT items developed by the researcher were done by first constructing a test blueprint. The blue print has lower reasoning level which connotes the first two categories/levels of (knowledge and comprehension) cognitive domain, while the higher reasoning level refers to reasoning abilities and skills operating in the levels of (application, analysis, synthesis and evaluation) of the cognitive domain.

Table 2: Test blue print for BSAT

Topic	No of Questions	%	Questions Distribution Base on Bloom Education Taxonomy					
			A	B	C	D	E	F
Work, energy & power	13	30.00	6	1	4	0	1	1
Simple Machines	16	40.00	4	3	7	2	0	0
Kinetic Theory	5	12.50	0	5	0	0	0	0
Thermal Energy	6	17.50	1	2	2	0	1	0
Total	40	100	11	11	13	2	2	1

Key: A = Knowledge B = Comprehension C = Application
D = Analysis E = Synthesis F = Evaluation

The six levels of cognitive domain are categorised into lower cognitive and higher reasoning processes because ability progress dimension of the test blue print is statistically evaluated when it is divided into two parts (Harbor- Peters, 1999).

Science Reasoning Tasks (SRT): Science Reasoning Tasks (SRT) was developed by the team "Concepts in Secondary Mathematics and Science at Chelsea College, University of London in 1978. It was developed to investigate the relationship between the optimum Piagetian level at which a learner can reason and the understanding of science for which he can achieve.

SRT is adopted in this study in order to assess reasoning ability of the respondents. The SRT is made up of 1-7 tasks but only task two is considered appropriate for this study. This is because the study focused on Upper Basic II students who are between the ages of 11-15. Task two is mainly for formal-operational level and appropriately for children between such age bracket (11-15 years).

SRT Tasks II Volume and Heaviness: The content of this task include the concept "size" in which mass, volume and density are involved. The task is hierarchically constructed with the first three items testing the lower reasoning ability at the concrete operational level. It has fourteen items altogether with internal consistency of 0.78 and test re-test reliability coefficient of 0.84 (Shayer, Adey & Wylam, 1981).

Although the test was developed and trial tested in London, it has been found to be effective in other countries of the world. For instance, Achor (2001) used it on Physics students in Kogi State and obtained reliable results. Bomide (1986) earlier used the instrument on Biology students in Plateau State and obtained reliability coefficient of 0.85 tasks II from a sample of 135 Upper Basic one students in Jos Metropolis which were considered adequate. And Ozoji (2010) used it on JSS III integrated science students in Plateau State and also obtained reliable results.

Each item is scored 0 for a wrong answer and 1 for a correct answer. The number of items correctly answered at each stage determines the reasoning ability of the student. Generally, two-third (2/3) pass criterion is often used. For the purpose of this study, students with scores less than 8 were regarded as low reasoning ability group and those with scores from 8 and above were regarded as high reasoning ability group.

Validation of Instrument and Lesson Plans

BSAT constructed by the researcher and the lesson plans were validated.

BSAT: A table of specification based on Blooms taxonomy of educational objective and the concepts to be taught was prepared. Fifty multiple choice questions were constructed and effort was made to use simple language in constructing the questions. On each question was marked the level of reasoning ability it was supposed to test. The instrument was given to a science educator (physics bias) from the University of Jos and lecturers teaching integrated science (physics bias) in the Departments of Integrated Science in FCE Pankshin and COE Gindiri. They were asked to check the clarity of expressions, adequacy and relevance of the questions to the objectives they were meant to test as well as the variables under study. Their individual criticisms and contributions led to the reduction of the number of questions to forty and in the reconstruction of some of the questions.

BSAT was trial tested using Upper Basic II Basic Science students from Plateau Southern Education Zone for six weeks of teaching and the results were used to conduct item analysis. The second instrument, the Science Reasoning Tasks (SRT) is a standardized test therefore it was used without validation but its reliability coefficient was determined afresh to be sure of it usability.

Lesson Plan: The lesson plan prepared by the researcher and the research assistants was also subjected to face validation. Four physics educators one from the University of Jos, one from FCE Pankshin and two from COE Gindiri were requested to check the lesson plan for grammatical and spelling errors as well as the appropriateness of the lesson plan to the level of the students it was intended for. They were also requested to give constructive suggestions that will enrich the lesson plans. In all, the valuators comments on the instruments indicated the need for grammatical corrections, reordering of the items in BSAT and reconstruction of some items.

From the trial testing the reliability of BSAT was determined using the Kuder Richardson 21(K-R21) formula. The reliability of BSAT was found to be 0.89. That of SRT II using test retest approach was found to be 0.81.

Data Collection Procedure: The teachers whose classes were used for the study were trained as research assistants. The researcher ensured that the research assistants have at least a minimum of a first degree certificate in integrated science, chemistry, physics or biology with at least three years post qualification experience. These research assistants were trained by the researcher using the lesson plans prepared by the researcher and the research assistants and the SRT. The research assistants that taught the experimental group were trained on how to effectively use the lesson plans to teach using prior exposure to content. The researcher used one of the prepared lesson plans on wheel and axle as a sample lesson using prior exposure to content. Students in addition to prior exposure to content were taught Basic science using expository strategy which combined demonstration, modified lecture and classroom interactions.

The control group was taught Basic Science using expository strategy only in which students were exposed to the contents via demonstration, modified lecturing and class interaction. They were denied prior knowledge of contents to be taught. This also lasted for eight weeks to ensure that equal grounds were covered as done for students in the experimental group. The SRT was administered as pre-test only. The pre-test was administered a day before the commencement of the study. Results from the pre-test were used for grouping students into different ability groups (that is, high and low ability).

The BSAT was administered as pre-test, post test to both the control and experimental groups. The pre-test was administered a day to the start of the treatment, which lasted for eight weeks. The teachers whose classes were used served as research assistants and they taught the students for the eight weeks. They also helped in the administration of the instruments as tests. Sampled schools within the same town or location did their tests the same day to avoid interference.

Results

The data obtained were analysed with respect to each question and each hypothesis. All the research questions were answered using mean and standard deviation. All the hypotheses were tested using two way Analysis of Covariance (ANCOVA).

Research Question One

To what extent do students exposed to content prior to instruction and those that were not differ in their achievement in basic science?

Table 3: Mean and standard deviation for students' achievement in BSAT

Group	Test	N	Mean	Standard Dev	Mean Gain
Experimental	Pretest	244	22.5861	7.6597	30.6516
	Posttest	244	53.2377	12.2320	
Control	Pretest	174	22.4713	8.5509	22.7298
	Posttest	174	45.2011	25.0657	
Mean Difference	-	-	-	-	7.9218

Table 3 reveals that the pre-test achievement scores of experimental group exposed to contents of Basic Science prior to the lesson in addition to expository lessons and control group exposed to expository lessons only are almost the same (22.5861 and 22.4713 respectively). The Table further revealed that the post-test mean achievement scores of the experimental group is higher than that of the control group (53.2377 and 45.2011 respectively). The mean gain of the experimental group is 30.6516 while that of the control group is 22.7298 and the mean gain difference is 7.92 in favour of the experimental group. This difference is appreciably high and it means that students exposed to contents of the subject prior to the lessons achieved high than the control group taught by expository strategy only.

Research Question 2

To what extent do male and female students exposed to content prior to instruction differ in their achievement in basic science?

Table 4: Mean and standard deviation of experimental male and female students' achievement in BSAT

Sex	Test	N	Mean	Standard Dev	Mean Gain
Male	Pretest	117	22.7607	8.0716	30.6154
	Posttest	117	53.3761	11.7779	
Female	Pretest	127	22.4252	7.2883	30.6850
	Posttest	127	53.1102	12.6812	
Mean Difference	-	-	-	-	0.0696

Table 4 reveals that the post test scores for both male and female students is higher than the pre-test scores. The post-test scores for male and female students are 53.3761 and 53.1102 respectively. The mean gain difference in achievement of the male and female students was found to be 0.070. This implies that prior exposure to content had almost the same effect on both male and female students.

Research Question Three

To what extent do low and high reasoning ability group students with prior exposure to content differ in their achievement in basic science?

Table 5: Mean and standard deviation of high and low ability students inexperimental group's achievement in BSAT

Ability level	Test	N	Mean	Standard Dev	Mean Gain
Low ability	Pretest	130	23.0538	7.9381	32.3770
	Posttest	130	55.4308	12.1852	
High ability	Pretest	114	22.4252	7.3278	30.6850
	Posttest	114	53.1102	11.8494	
Mean Difference	-	-	-	-	1.6920

Table 5 reveals that the mean pre-test and post-test for high and low reasoning ability students are 23.0538 and 22.0526 for pre-test and 55.4308 and 50.7368 for post-test. The mean gain for the two groups is 32.377 and 28.6842 respectively. The mean gain difference is 1.69 in favour of the high reasoning ability group, implying that the high reasoning ability group achieved more than the low reasoning ability group after exposure to the treatment

Hypothesis One

There is no significant difference in the achievement mean scores of basic science students exposed to content prior to instruction and those that were not.

Table 6: Two way ANCOVA of students' mean achievement scores in BSAT

Source	Sum of squares	df	Mean square	F	Sig of F
Corrected model	1249.342a	8	1564.418	4.594	.0001
Intercept	91313.346	1	91313.346	268.467	.0001
Pretest	796.547	1	796.547	2.342	.127
Method	5241.313	1	5241.313	15.410	.0001
Sex	2383.089	1	2383.089	7.006	.008
Ability level	1491.673	1	1491.673	4.386	.037
Method*sex*ability	249.911	1	249.911	.735	.392
Error	139112.813	409		340.129	
Total	1192117.00	418			
Corrected total	151612.156	417			

a. R Squared= 0.082 (Adjusted R Squared=0.064)

The summary of the results of the Analysis of Covariance (ANCOVA) of students' mean achievement scores in BSAT, presented on Table 6 shows that the difference in the mean achievement scores of students who were exposed to content prior to instruction and those that were not, is significant at 0.0001 ($F_{1,417}$ =15.410, P< 0.05). Therefore, the null hypothesis of no significant difference in the achievement mean scores of students exposed to content prior to instruction and those that were not was rejected. This implies that prior exposure to content does enhance students' achievement in basic science.

Hypothesis Two

There is no significant difference in the achievement mean scores of male and female basic science students exposed to content prior to instruction.

Table 7: Two way ANCOVA of male and female students' mean achievement in BSAT

Source	Sum of squares	df	Mean square	F	Sig of F
Corrected model	3971.192a	4	992.798	7.326	.0001
Intercept	46595.916	1	46595.916	343.855	.0001
Pretest	2591.043	1	2591.043	19.121	.0001
Sex	44.691	1	44.691	.330	.556
Ability level	1139.980	1	1139.880	8.412	.004
Error	32387.021	239	135.511		
Total	727916.000	243			
Corrected total	36358.213	244			

a. R Square = .109 (Adjusted R Squared = .094)

The results of the 2-way ANCOVA on Table 7 indicated that the calculated F value for the main effect of sex on achievement is 0.33, and is significant at 0.556 ($P > 0.05$). Therefore the null hypothesis of no significant difference between the mean achievement scores of male and female students exposed to content prior to instruction was not rejected. This implies that the achievement of male and female students exposed to content prior to instruction do not differ significantly ($F_{1,\ 243} = 0.33$; $P > 0.05$)

Hypothesis Three

There is no significant difference in the achievement mean scores of high and low ability basic science students exposed to content prior to instruction.

Table 7 is used to test hypothesis three. The results of the 2-way ANCOVA on Table 7 revealed that the calculated F value for the main effect of ability level on achievement is 8.412 which is significant at 0.004 ($P < 0.05$). Therefore the null hypothesis of no significant difference in the achievement mean scores of high and low ability group students exposed to content prior to instruction was rejected at $P < 0.05$. This implies that the mean achievement scores of high and low ability level students exposed to content prior to instruction differed significantly ($F_{1,\ 243} = 8.412$; $P < 0.05$)

Hypothesis Four

Interactions among group, ability level and sex have no significant influence on student's achievement mean score in Basic Science.

Table 6 was used to test hypothesis four. The result of the analysis of covariance of students overall achievement scores in BSAT on Table 6 show that F value calculated for the interaction between method, sex and ability level is 0.735 and is not significant since p-value of 0.392 is greater than 0.05. Therefore the null hypothesis that there is no significant interaction effect of method, sex and ability level is not rejected ($F_{1,417} = 0.735$, $P > 0.05$).

Discussion of Findings

The study sought to determine the effects of prior exposure to content on Upper Basic II students' achievement in basic science. It was found that prior exposure to content was superior enhanced students' achievement in basic science. ($F_{1,\ 417}$ = 15.410; P < 0.05). In relative term, experimental group performed better than the control group taught basic science using expository strategy only. This agrees with the view expressed by Nkwo, Akinbolola and Edinyang (2008) and the findings of Ogbeba (2009) who found that prior knowledge of instructional objectives positively affects students' learning of physics and Biology respectively. Although the present study is on prior exposure to content, the finding could be explained by the fact that the content exposed to the students prior to instruction emphasises self-construction of knowledge, the making of connections and the use of models (mental, conceptual and physical) which are enhanced through active engagement of learners. Involvement of the learners throughout class activities is said to improve achievement (Nwagbo & Chukelu, 2011).

The effect of prior exposure to content on the achievement mean scores of male and female basic science students was also a concern in the study. The difference was not statistically significant ($F_{1,\ 244}$ = 0.33; P> 0.05). This implies that prior exposure to content is favourable to both sexes. This is consistent with the findings of Inyang and Ekpenyoung (2000) and Sungur and Tekkaya (2003) who found no significant difference in the achievement of science students based on gender. The finding agrees with Mboto and Ogar (2004) and Igboko and Ibeneme (2006) who found that teaching approach that allows students to be exposed to the learning materials and to construct their own knowledge positively influences students' achievement and retention. The implication is that prior exposure to content tends to eliminate gender difference in basic science achievement of students. This finding contradicts Nkwo, Akinbibola and Edinyang (2008) who found that male students' achieved higher than their female counterparts given the same condition of exposure to prior knowledge of objectives of physics concepts. The present work focused on prior exposure to content and not objectives. Also the work of Nkwo, Akinbolola and Edinyang (2008) was on physics not basic science. These reasons may account for the observed difference. Also the content exposed to the students was not gender discriminative hence the present result is quite expected. Thus prior exposure to content enhanced both male and female students' achievement in basic science.

The result from this study shows that the mean gain difference in the post test achievement scores of high and low ability group basic science students exposed to content prior to instruction is 1.69 in favour of the high reasoning ability group. Further ($F_{1,\ 244}$ = 8.412, P < 0.05), the result revealed that there is a significant difference in the mean achievement scores of high and low ability group students on BSAT. The result is also consistent with the finding of Chukwu (2010) who also found that cognitive factors such as reasoning ability is a good predictor of achievement in science. The persistent underachievement in Basic Science may be because the students are sent to school at much early age and as such may not have developed the required reasoning skill needed to handle the task required by the curriculum as was pointed out by Ozoji (2008). One implication of this situation is that when students do not do well in basic science consistently, it tends to affect their interest in the subject (Okigbo & Okeke, 2011). Hence the idea of evolving teaching strategies such as exposure to content prior to instruction is considered appropriate.

The study also investigated if interactions among group, ability level and sex have an influence on students' mean achievement in basic science. The result shows that there is no significant interaction effect of group, ability level and sex on students' achievement in basic science. Thus interactions among groups, ability levels and sex have no significant effect on students' achievement. Thus exposing students to content prior to instruction affects male and female students as well as high and low ability level students equally. The implication is that exposing students to content prior to instruction can be used in teaching since it does not discriminate by gender or ability level.

Conclusion

Based on the findings of the study it was concluded that prior exposure of students to content of basic science significantly improved achievement. Similarly, achievement of high and low reasoning ability level students significantly differed. The study also concluded that male and female basic science students exposed to content prior to instruction do not differ significantly in their achievement.

Recommendations

Based on the findings of this research the following recommendations were made.

1. Basic science teachers should expose contents to students prior to instruction as this will go a long way to improve the students' achievement.
2. Basic science teachers should be made to be aware of the relationship that exists between reasoning pattern of learners, conceptual demand of the school subject and the methods of teaching that will facilitate good performance
3. Basic science teachers should be adequately trained on the use of prior knowledge of content for classroom instruction.
4. Authors of methodology text books should include and explain carefully how prior knowledge of content can be used to enhance achievement of learnt materials.

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