Effectiveness of Mind-Mapping Teaching Strategy in Enhancing Senior Secondary School Students' Achievement and Interest in Computer Studies

Okereke, C. M.
Registry Department, Federal University of Technology, Owerri, Imo State, Nigeria
chuksmartinokereke@gmail.com
&
Okigbo, E. C.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
ec.okigbo@unizik.edu.ng

Abstract

The effectiveness of mind-mapping teaching strategy in enhancing senior secondary school students' achievement and interest in computer studies of Owerri municipal council of Imo State was determined. Six research questions guided the study while six hypotheses were formulated and tested at 0.05 level of significance. The design adopted for the study was the quasi-experimental, non-equivalent pre-test and post-test control design. The population is made up of 1,052 Senior Secondary Two (SS II) Computer studies students found in the 4 co-educational schools within Owerri Municipal Council of Imo State in 2017/2018 academic session. The sample of the study consisted of 105 SS II students which was sampled through purposive and multistage sampling technique. Data were collected using researcher-made Computer Studies Achievement Test (CSAT) and Computer Studies Interest Inventory (CSII). The reliability coefficients obtained for the CSAT and the CSII were 0.84 and 0.72 using Kuder Richardson formula-20 and Cronbach alpha procedure respectively. Data collected were analysed using mean and standard deviation to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses. Findings indicated significant effect of mind-mapping over the conventional strategy in CSAT and CSII ($P < 0.05$). Gender ($p > 0.05$) was not significant factor in determining students' achievement and interest in mind-mapping group. Results further indicated a significant interaction effect of teaching strategy and gender ($P < 0.05$), both in CSAT and CSII. Based on the findings, it was recommended among others that computer studies teachers should use mind-mapping strategy to improve students' achievement and interest in computer studies irrespective of their gender.

Keywords: Computer Studies, Achievement, Interest, Mind-Mapping Strategy.

Introduction

Science education is a very essential tool for sustainable development. It has greatly affected the lives of the average citizen that to be ignorant on the basis of this development is to live an empty, meaningless and hence unrealistic life. The importance of science and technology education on the overall development of any nation is acknowledged worldwide. It

is due to this importance that the Federal Republic of Nigeria (FRN, 2013) in the National Policy on Education emphasized the teaching of science and technology at all levels of Education. Jibrin (2014) also acknowledged that science and technology education can help individuals to participate fully and intelligently in education sector.

The valuable role of science in the technological development of any nation is never in dispute. Fafunwa (2017) opined that we are living in a world where science and technology have become an integral part of the world's culture, and any country that over looked this significant statement does so at its own peril. Hence, a solid background in the basic sciences is very critical if Nigeria has to attain the required science and technological development height. One of such basic sciences is Computer science. At secondary levels of education, Computer Science as a school subject is called Computer Studies. Computer studies are not about learning how to use the computer, and it is much more than computer programming. It is the study of ways of representing objects and processes. It involves defining problems; analysing problems; designing solutions; and developing, testing, and maintaining programs. Computer studies, according to Edhuze (2013) involve teaching and inculcating in the learner the basic skills required to independently manipulate the computer to achieve educational goals. Edhuze further stated that, computer studies as a subject is aimed at making students acquire skills and competencies required in this digital word of competitiveness. Such basic skills and competencies upon graduation make them conversant with term and practices embedded in the world of computer. Computer studies are therefore a subject organized to enable people understand the function, uses and limitations of the computer and to provide an opportunity for the study of the modern methods of information processing.

The intention of Nigeria to include computer studies in the secondary school curriculum dates back to 1988 when the National Policy on Computer Education was enacted and launched

(Abimbade, 2014). The policy on computer education suggested the following as some of the computer curriculum context at the secondary school level: A basic appreciation of how the computer works, an understanding of the basic principle of operating the computer, hands-on experience using the pre-programmed packages which are relevant to the interest of the students as teacher aids in different subjects. According to the National Policy on Computer Education (2014), it is expected that by the end of secondary education, the child has acquired reasonable competence in software such as word processing, spreadsheet, database and analysing programs that allow learners interact with the computer the way they desire. One of the major merits of the National Policy on Computer Education, is that it recommended the introduction of computer studies at all secondary schools in Nigeria. The committee on the policy recommended a total lifting of restriction on computer studies in a way that computer literacy program can begin right from primary school. According to the committee, computer studies should be introduced at any level provided the necessary facilities and resources are adequately provided for effective implementation. Since then, effort has been made to include computer studies in the primary and secondary school curriculum.

Report by the Chief Examiner, West African Senior School Certificate Examination (WASSCE, May/June 2014-2017) on students' academic performance in Computer studies showed that the pass rate at credit level decreases gradually as the failure rate increases correspondingly in 2014 and 2016. In 2015 and 2017, the pass rate at credit level fluctuates below average (50%) as the failure rate increases and fluctuates below average respectively also. This shows poor trend of performance. The pass rate at credit level in 2014 and 2016 were 50.94% and 50.94% respectively while their corresponding absolute failure rate (grade 9) were 32.55% and 27.28%. Therefore, the students' pass rate at credit level was on the average in 2014 and 2016. This also shows a poor trend of performance. Ifegbo (2014) had earlier reported a poor trend of performance in Computer studies from 2014 to 2017 respectively. (WAEC

Annual Reports from 2014 – 2017). Ifegbo (2014) attributed the low achievement in secondary school Computer studies to teachers' non utilization of appropriate teaching methods. Furthermore, Ifegbo also specifically noted that the use of ineffective teacher centred-strategies like conventional teaching method account for the highest poor performance. In addition, Ayogu (2014) remarked that most teachers in Nigerian secondary schools still believe that the most effective means of communicating to students' is through the conventional "talk and chalk" method of teaching.

The conventional teaching method is a method in which the teacher presents a verbal discourse mainly on a particular subject, theme or concept to the learners. The teacher delivers pre-planned lessons to the students with little or no instructional aid that involves students' activity (Okoli, 2016). Secondary school teachers very often teach subjects by conventional teaching method (CTM). This may be because the method is the easiest to deliver and large contents are usually covered by the teacher using the method. This may be why majority of teachers often use this method without recourse to constructive teaching methods that promote the acquisition of scientific and technological skills in learners. The use of conventional teaching method, sometimes involves questions and answers, practical and practices and showing of teaching aids may be involved but, hands on activities of the teacher and students are seldom involved.

Computer studies teachers have been teaching their students using CTM over the years (2010-2016). Opara (2017) further opined that WAEC annual reports for the slated years revealed that students' pass rate at credit level in computer studies were poor as earlier reported. This is an indication that the use of CTM in teaching computer studies has not delivered effectively. The situation therefore calls for exploration of other teaching methods found effective in some other fields and countries (Okoli, 2016). Opara (2017) proposed that teachers

should use teaching strategies that are helpful in nature and which should involve learners' active participation and encourage skill acquisition. Such strategies could be able to generate interest among students in the learning process. This is because it is expected that students' learning of Computer Studies through using realistic instructional techniques should enhance the inculcation of the generic skills of inquiry, reasoning, conceptualizing, problem-solving and communicating. By applying these skills, students are not only expected to construct their knowledge of computer studies but also to establish confidence and positive attitudes toward computer studies. One way of achieving this may be through the adoption of student-centred, activity-based and minds-on approaches that cater for individual needs and differences, learning styles, interests and abilities. One such student-centred, inquiry-based approach to organize learning is mind mapping.

Mind-mapping is a teaching method which is visual and non-linear representation of ideas and their relationship (Buzan, 2010). The method is student-centred as described by Lea, Stephenson and Troy (2013) who pointed out that it allows learners to be active rather than passive listener and emphasized deep learning and understanding. Mind-mapping method is a beneficial learning method to help students brainstorm any topic and think creatively. Mind-mappings are particularly helpful in the writing process and provide students with a natural way of thinking and building thoughts on a story plot or theme. The Mind-mapping, which represents and classifies the knowledge is a powerful graphic technique for uncovering the potential of the brain (Amma, 2014). Generally, a Mind-mapping provides and organize knowledge by means of hierarchies and categories. Along with this, those hierarchies and correlations in Mind-mapping spread around meaningfully from a central image without a certain order (Budd, 2015). That is to say, Mind-mappings are the expression of the radiant thinking on a piece of paper. The radiant thinking is about the associated thinking processes which connect to a central point or originate and advance from a central point. This

phenomenon takes place naturally and spontaneously in the brain functions of all people (Gugenheimer & Szule, 2012; Amma, 2014). Mind Maps can be used to increase the performance of humans in all areas of life.

Mind-mapping has also been described as one of the teaching strategies that promote creative thinking, ability and high retention in learners. It is a powerful tool that teachers can use to enhance learning as it is evident in brainstorming, note taking, problem solving, memory learning and visual thinking technique used by psychologist, educationist and other professionals (Yusuf, 2012). Yusuf added that mind-mapping enhances the development of certain skills in learners such as thinking skills, reasoning skills and ability to make decision, taking action, information gathering and generating skills. Types of mind maps are (1) reference mind maps which is used for keeping document (2) planning mind maps used in making plans (3) institutions and presentation mind maps used for training in schools. The institutions and presentation mind maps will be relevant in the course of this study because it is relatively important in education. According to Buzan (2010), mind-mappings can be used in teaching in the following ways: place an image or topic in the centre at least using three colours, use image symbol codes and dimension throughout your mind-mappings, select key word and print using upper or lowercase letters and each word is alone and sitting on its line. Buzan (2016) stated that mind-mapping teaching strategy (MMTS) is a constructive and classification graphic organizer of ideas which uses the cortical skills to unlock the brain potentials. Buzan added that a mind-mapping is a powerful graphic organizer of ideas, which provides a universal key to unlock the potential of the individual brain. It harnesses the full range of cortical skills, words, image, number, logic, rhythm, colour and spatial awareness in a single uniquely powerful manner. In doing so it gives the learner the freedom to roam the vast expanse of his or her brain. This study therefore will explore how MMTS will help improve the achievement of male and female computer studies students in schools.

Achievement is the feeling of getting things done as we desired or getting things that we expected. It is not only reaching greater heights but also getting something after a bit of struggle. Academic achievement is the extent to which a student, teacher or institution has achieved their short or long-term educational goals. Its achievement is commonly measured through examinations or continuous assessments but there is no general agreement on how it is best evaluated or which aspects are most important procedural knowledge such as skills or declarative knowledge such as facts. Anaekwe (2009) used interaction patterns to evaluate students' achievement in Computer studies. He found out that there was significant difference in the mean achievement score of boys and girls in computer studies in favour of boys. Similarly, Ifegbo (2014) used peer assessment to evaluate mean achievement scores of students in computer studies. She found out that there was significant difference in mean achievement score of males and females in favour of males. Conversely Njoku (2005) reported that there was no significant difference in the mean achievement score of males and females in secondary school computer studies. Therefore, research findings have shown contradictory evidence in achievement and interest of students in computer studies influenced by gender.

Interest is a feeling or emotion that causes attention to focus on an object, event, or process. It is used as a general concept that may encompass other more specific psychological terms, such as curiosity and to a much lesser degree surprise. Interest could be defined as an activity one enjoys and devotes his/her time in studying or doing. It can also be seen as a feeling one has in the cause of wanting to know or learn more about something or somebody. Interest differs from one's personal attitude which refers to the manner of behaving towards somebody or something. Chauhan (2007) described interest as an activity that drives or motivates the individual for action. Unfortunately, there are strong indications of gender biases that pervade Science and Technology curricula used in Nigerian secondary schools (Olagunju, 2011). These biases are in terms of choice of drawing or pictures of illustrations of science and technology

activities, language of expressions used in Science and Technology books, teachers' choice of activities used in science teaching etc. Females' interest and daily experiences are rarely considered for inclusion in the Science and Technology books (Njoku, 2005). Ezeudu (2015) reported that influence of gender on interest in Computer studies was not significant. This finding is in support of Obodo (2011) in which he reported that the experimental and control groups had equal changes in interest in science and mathematics. However, the findings were in disagreement with that of Chidolue (2013) who reported that females showed more interest than males in Computer Studies while Balogun (2015) reported that more boys than girls tend to opt for all the basic sciences at SSCE examinations. Therefore, the status of students' interest in computer studies is inconclusive. Teaching with MMTS may contribute effectively to the inconclusive findings on students' interest in their learning.

Statement of the Problem

There is a growing concern about which strategy or method of teaching in our secondary schools should be able to reverse deteriorating trends in students' poor achievement in Computer Studies. Some suggestions have been made regarding the identification of science teaching methods and strategies which motivate students better to learn and achieve superior results in their study of Computer Studies. Research results reveal that the methods presently in use by teachers of Computer Studies are the traditional, talk or lecture rather than the strategies that involve students' participation (Agwagah, 2013). Probably, the non-use of innovative methods that are problem solving oriented such as concept maps, mind maps and so on could be the main cause deteriorating students' achievement and low interest in Computer Studies. Mind-mappings however, has been used as an effective strategy in enhancing students' achievement both in Computer Studies and other subjects outside Nigeria and may produce the desired effective teaching of senior secondary Computer Studies such that students' achievement and interest improve. There is no evidence in literature known to the researchers

of the use of mind-mappings in the teaching of secondary school Computer Studies here in Nigeria. Therefore, the problem of this study, put in question form is: Could the use of MMTS enhance the achievement and interest of senior secondary students in Computer Studies?

Research Questions

The study answered the following questions:

1. What is the difference in the mean achievement scores of students taught computer studies using to mind-mapping strategy and those taught using the conventional method?
2. What is the difference in the mean interest scores of students taught computer studies using to mind-mapping strategy and those taught using the conventional method?
3. What is the difference between the mean achievement scores of male and female students taught computer studies using mind-mapping strategy?
4. What is the difference between the mean interest scores of male and female students taught computer studies using mind-mapping strategy?
5. What is the interaction effect of strategy and gender on students' achievement in CSAT?
6. What is the interaction effect of strategy and gender on students' achievement in CSII?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 significant level:

1. There is no significant difference in the mean achievement scores of students taught computer studies using to mind-mapping strategy and those taught using the conventional method.

2. There is no significant difference in the mean interest scores of students taught computer studies with mind-mapping strategy and those taught using the conventional method.
3. There is no significant difference between the mean achievement scores of male and female students taught computer studies using mind-mapping strategy?
4. There is no significant difference in the mean interest scores of male and female students taught computer studies with mind-mapping strategy.
5. There is no significant interaction effect between gender and teaching method as measured by the mean scores in CSAT.
6. There is no significant interaction effect between gender and teaching method as measured by the mean interest scores in CSII.

Method

This study adopted pre-test, post-test non- equivalent control group type of quasi experimental design. The population is made up of 1,052 Senior Secondary Two (SS II) Computer studies students found in the 4 co-educational schools within Owerri Municipal Council of Imo State in 2017/2018 academic session. The sample of the study was 105 SSII Computer studies students was drawn through purposive and multistage sampling procedure. The instruments CSAT and CSII were developed by the researcher, validated by experts. The reliability coefficients obtained for the CSAT and the CSII were 0.84 and 0.72 using Kuder Richardson formula-20 and Cronbach alpha procedure respectively. Data obtained from this study were analysed. Mean and Standard deviation scores were used to answer the research questions while the hypotheses were tested at $P<0.05$ level of significance using Analysis of Covariance (ANCOVA).

Experimental Procedure

Two lesson plans one for the experimental (MMTS) and the other for the control (CTM) were prepared by the researcher. The teachers used them for teaching the subjects. On the first day of the experiment the instruments (CSAT and CSII) were administered by their regular teachers as pre-test. An hour was allowed for the test. The test was marked, collated and collected by the teachers and handed over to researcher. Teaching commenced on the next computer studies period by the teachers for 5 weeks. Five weeks after, post-test was administered. An hour was allowed for the test. The test was marked, collated and collected by them and handed over to the researcher. Some of the extraneous variables controlled in this study were effect of pre-test on post-test, Hawthorne effect, initial group differences, instruction situation variable, subjects' interaction, novelty effect, teachers' variable and training of teachers.

Results

Table 1: Mean and standard deviation on mean achievement scores of students taught computer Studies using MMTS and conventional method

Group	N	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
MMTS	52	33.2	62.9	29.6	9.43	11.3
Conventional Method	53	30.2	51.4	21.2	8.84	12.9

From Table 1, MMTS group has a mean gain score in achievement of 29.6 while conventional lecture mean gain score of 21.2. This shows that MMTS is very effective on students' achievement in Computer Studies. Also, from Table 1, MMTS group has a higher standard deviation score of 9.43 in pre-test than the lecture method group with standard deviation in pre-test of 8.84. Conversely in the post-test, MMTS group has a lower standard deviation of 11.3 while the lecture method (12.9). Thus, the table reveals that the standard deviation score for each group is low in both pre-test and post-test. By implication, it shows that groups used in this study are homogeneous.

Table 2: Mean and standard deviation on interest scores of students taught computer Studies using MMTS and conventional method

Group	N	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
MMTS	52	57.7	119.0	61.3	15.1	15.1
Conventional Method	53	57.7	115.0	57.3	12.3	12.3

From Table 2, the gain score in interest of students taught using MMTS is higher (61.3) than the gain score in interest (57.3) of those taught with the lecture method group. This indicates that the use of MMTS enhanced the mean interest score of students. Also, the standard deviation (15.1) for the pre-test and post-test scores of MMTS group is the same with that of the standard deviation of the lecture method group in pre-test and post-test scores. This shows that the interest of the MMTS group prior to and after the treatment is equally spread. Thus, the two groups have homogeneous interest in computer studies before and after treatment.

Table 3: Mean Achievement scores of Male and Female subjects taught with MMTS

Group	N	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
Male	42	33.6	61.1	27.5	10.7	12.4
Female	63	30.6	54.5	23.9	7.98	13.6

From Table 3, the mean gain score in achievement of male (27.5) is higher than the mean gain score of their female (23.9) counterparts taught Computer Studies with MMTS. Table 4 further reveals that male students had higher standard deviation (SD) score before treatment (10.7) and lower SD after treatment (12.4) than their female counterparts whose standard deviation score is (7.98) before treatment and (13.6) after. In general, male students achieved higher than their female counterparts when taught with MMTS.

Table 4: Mean Interest scores of Male and Female subjects taught with MMTS

Group	N	Mean Pre-test	Mean Post-test	Mean Gain Score	SD Pre-test	SD Post-test
Male	42	33.6	194.3	160.7	10.7	12.2
Female	63	30.6	199.1	168.5	7.98	14.5

Table 4 shows that the mean gain score in interest of female (168.5) is higher than that of their male (160.7) counterparts in Computer Studies. Also the male students have a standard

deviation scores (10.7) before and (12.2) after treatment while their female counterparts have SD scores are 7.98 and 14.5 in pre-test and post-test respectively.

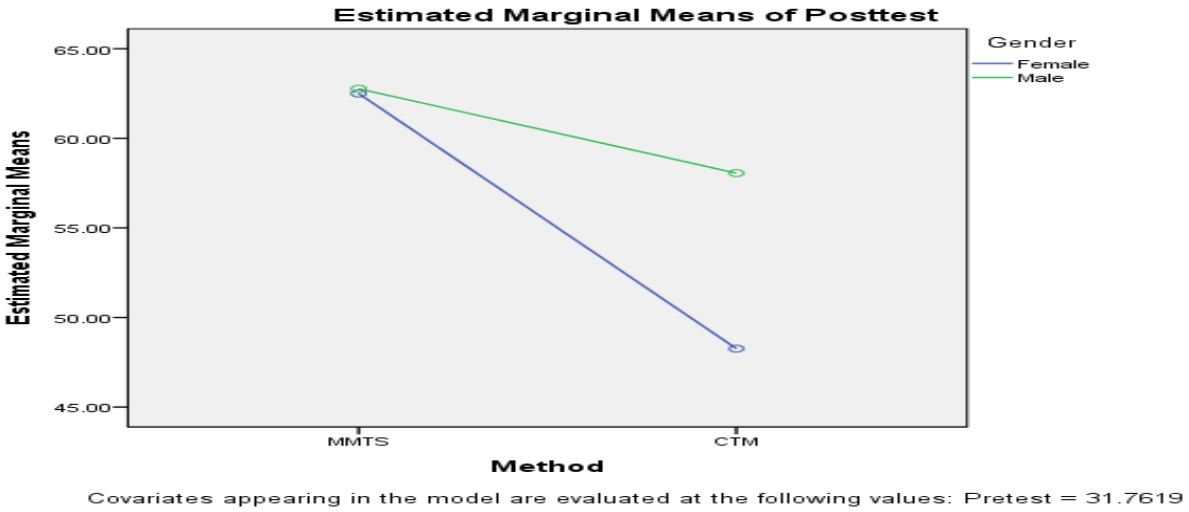

Figure 1: Interactive effect of teaching strategies and gender on students' achievement in computer studies

Figure 1 presents the profile plot showing the interaction effect of teaching strategies and gender on students' achievement in computer studies. The interaction pattern shows that the plots for males and females intercepted and were not parallel. This indicates that there is a likelihood of an interaction effect between strategies and gender in CSAT especially when the two lines are crossed.

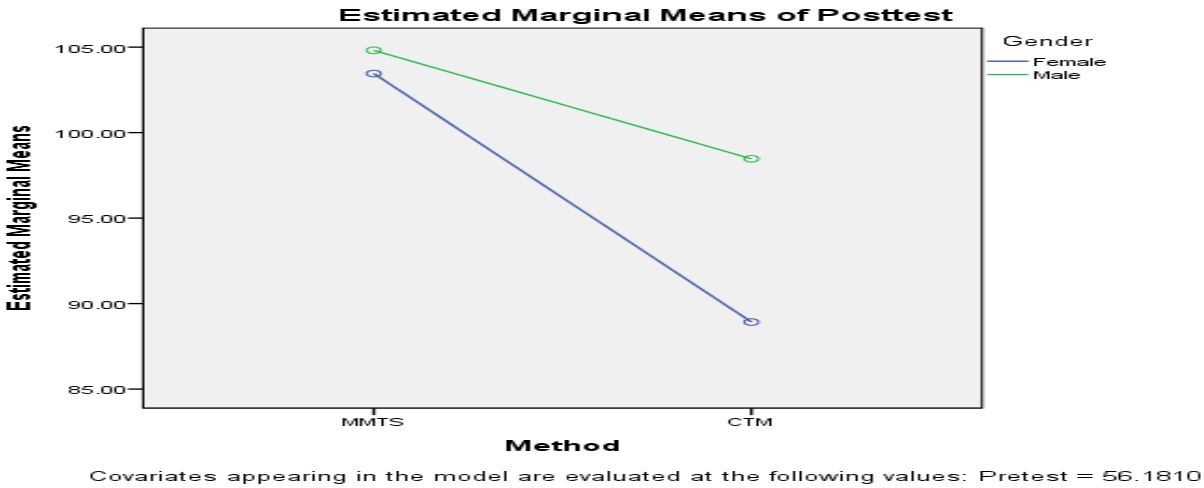

Figure 2: Interactive effect of teaching strategies and gender on students' interest in computer studies

Figure 2 presents the profile plot showing the interaction effect of teaching strategies and gender on students' interest in computer studies. The interaction pattern shows that the plots for males and females slightly intercepted at the long run and were not parallel. This indicates that there is a small likelihood of an interaction effect between strategies and gender in CSII especially when the two lines are crossed.

Hypothesis Testing

Table 5: ANCOVA Comparison Difference between the Achievement of MMTS group and Conventional group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5168.045a	4	1292.011	9.518	.000	.276
Intercept	18747.776	1	18747.776	138.107	.000	.580
Pre-Test	476.628	1	476.628	3.511	.064	.034
Method	2167.686	1	2167.686	15.968	.000	.138
Gender	618.819	1	618.819	4.559	.085	.044
Method * Gender	551.428	1	551.428	4.062	.047	.039
Error	13574.812	100	135.748			
Total	361600.000	105				
Corrected Total	18742.857	104				

Table 5 reveals that significant difference exists between the achievement scores of students taught computer studies with MMTS and those taught with lecture method in favour of MMTS group. This shows that the MMTS is very effective ($p = .000 < 0.05$). From the result of the ANCOVA test as shown in Table 5, the statement of hypothesis 3 is accepted; implying that there is no significant difference in the mean achievement scores of male and female students taught computer studies using MMTS ($p = .085 > 0.05$). Table 5 also reveals that there was a significant interaction between gender and teaching method (MMTS) as measured by the mean achievement scores in computer studies ($p = .047 < 0.05$). Therefore, hypothesis 5 is up-held. This shows that the achievement of students in relation to MMTS is not influenced by gender of the students. Both male and female students benefitted equally from MMTS.

Table 6: ANCOVA Comparison Difference between the Interest of MMTS group and Conventional group

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	17971.856a	4	4492.964	330.330	.000	.930
Intercept	23430.162	1	23430.162	1722.623	.000	.945
Pre-Test	16660.878	1	16660.878	1224.934	.000	.925
Method	31.600	1	31.600	2.323	.031	.023
Gender	18.383	1	18.383	1.352	.248	.013
Method *Gender	.245	1	.245	.018	.893	.000
Error	1360.144	100	13.601			
Total	1456677.000	105				
Corrected Total	19332.000	104				

Table 6 shows that significant difference also exists between the interest scores of students taught computer studies with lecture method and those students taught with MMTS in favour of MMTS group ($p = .031 < 0.05$). This shows that MMTS improve the interest of students in computer studies. From the result of the ANCOVA test as shown in Table 6, the statement of hypothesis 4 is accepted; implying that there is no significant change in the mean interest scores of male and female students taught computer studies with mind-mapping strategy($p = .248 > 0.05$). Table 6 also reveals no significant interaction between gender and teaching method (MMTS) as measured by the mean interest scores in computer studies ($p = .893 > 0.05$). Therefore, hypothesis 6 is up-held. This shows that the interest of students in relation to MMTS is not influenced by gender of the students.

Discussion

This study revealed that mean achievement score of students taught using MMTS was significantly higher than those of the students taught using conventional teaching method (CTM). The reasons for the higher achievement by the experimental group could be that they were more actively involved in mind mapping of the concepts and principles of Computer Studies which involved drawing and painting the maps which were absent in the control group throughout their lesson periods. It could also be that the experimental group members were

able to link up new concepts in Computer Studies to the relevant concepts in their mind mapping which they were familiar with. This was absent in the conventional teaching method.

In addition, it could be as a result of excitement over creating new shapes (maps) emerging on their own from each topic which was similar or nearly the same with that of their teachers. Furthermore, the mind mapping and pictorial adjunct mode presentation provided by the MMTS was completely absent in the CTM. The teacher and student's participatory role in mind mapping technique is unique which made for better achievement of the MMTS group than the CTM. This was also completely absent in CTM group. The above findings observed when mind mapping teaching strategy was used to teach one group of students supported the findings of Ezeudu (2005) who used different structural graphic organizer concept map. The result also supported the works of Anaekwe (2007) and Entrekin (2012) that used effect of students' interaction patterns and found significant effect on the mean achievement score of students in their studies. The researcher therefore tenders that most teaching strategies which involve active participation of the students and encourage hands on minds on activities by the students have been found significant achievement score in their studies.

This study revealed that the mean achievement score of students taught using MMTS was not significantly influenced by gender. This is an indication that gender inclusive science teaching strategy (MMTS) does not influenced mean achievement score of students in their mind mapping of Computer activities. This also implies that the use of gender inclusive instructional mind mapping teaching strategy may not have influenced the gender groups positively. Generally, there are two categories of result from studies on gender influence on mean achievement score. The finding of this study did not support the first category in which there was significant gender influence on mean achievement scores (Ezeudu 2005; Ifegbo, 2005; Anaekwe 2007). Conversely, the result corroborated with the findings of the second

category in which there was no significant gender influence on mean achievement scores (Okerie, 2009; Joseph, 2009; Falade, 2012).

The result of this study revealed that the mean interest score of students taught using MMTS was significantly higher than the mean interest score of those taught using CTM. Thus, the use of mind mapping teaching strategy enhanced the mean interest score of students. This means that the mode of instruction has significantly affected the mean interest score of the students. The overall higher mean interest score shown by the treatment group against the control group was as a result of high level of activities and excitement over creating new shapes and structures (maps) emerging from their intellect and is similar to that of their teachers. Furthermore, the pictorial adjunct mode of presentation by the use of MMTS activities stimulated interest in the experimental group. Finally, the researcher tenders that constructive teaching strategy (MMTS) is not a gender inclusive instructional technique and involves hands on minds on activities was the main source of their interest. The finding was in agreement with Ozofor (2001) and Ezeh (2002). This finding also agreed with Ezeudu (2005), Anaekwe (2007).and Nwaigwe (2010). One can rightly say that mind mapping has the ability of arousing and sustaining interest. This study revealed that the mean interest score of students taught was not influenced significantly by gender. This is an indication that gender had no influence on the mean interest score of students taught using MMTS. Any observed difference in mean interest score is due to chance. This finding contradicted Nworgu (1990) and Obodo (1990) in which they reported that students' interest towards science was significantly dependent on gender.

However, the finding is in line with that of Anaekwe (2007) and Ifegbo (2009) which reported no significant effect of gender on students' development of interest in Computer studies. They also reported that female students showed equal interest with their male

counterpart. Some studies on gender influence on students' interest in science were of the opinion that boys are more exposed to scientific activities very early in life than girls. Moreover, they are more encouraged to enter for science related courses like engineering and technology while girls go for biology, home economics and other related domestic subjects. The result of this study has shown that giving equal science and unlimited access to education for females, they would as well develop interest in physical sciences like Computer studies. The implication is that the use of MMTS gender inclusive strategy has eliminated masculine image of science related differences in students' interest in favour of the girls in this study.

Recommendations

1. Computer studies teachers should use mind-mapping strategy to improve students' achievement and interest in computer studies irrespective of their gender.
2. Workshops and seminars should be organized for in-service Computer studies teachers. The teacher training institutions should include the use of MMTS in their Computer studies method course content to ensure the training of the pre-service Computer studies teachers.
3. Authors of Computer studies text-books should include MMTS in their texts for easy access for students and teachers.
4. Curriculum planners should include MMTS in senior secondary Computer studies scheme for teachers and students.

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Effect of Crossword Puzzle Game on Secondary School Students' Academic Achievement in Chemistry in Awka Education Zone of Anambra State, Nigeria

Joshua, G. A.[1], & Okoli, J. N.[2]

[1, 2]Department of Science Education, Nnamdi Azikiwe University Awka, Anambra State, Nigeria

[1] cutepearl30@mail.com [2] jn.okoli@unizik.edu.ng

Abstract

This study determined the effect of crossword puzzle game on secondary school students' academic achievement in chemistry in Awka Education Zone of Anambra State, Nigeria. Three research questions and four null hypotheses guided the study. Quasi experimental research design was adopted for the study. Population of the study comprised all the 1,011 SSI students in the 15 government owned coeducational secondary schools in Awka Education Zone. A sample of 139 (53 males and 86 females) senior secondary one (SSI) chemistry students who were selected from two schools out of the 15 co-educational secondary schools in the zone using multistage sampling procedure were involved in the study. Chemistry Achievement Test (CAT) which was validated by experts in chemistry, measurement and evaluation was the instrument used for data collection. Kuder- Richardson Formula 20 (KR) reliability coefficient of 0.72 was established. Data were analysed using mean, standard deviation and Analysis of Covariance. The findings revealed that students who were exposed to use of crossword puzzle game achieved significantly higher than those taught using the conventional method. It was concluded therefore that the use of crossword puzzle game enhances students' academic achievement in chemistry. Based on the findings, it was recommended among others that chemistry teachers should learn to incorporate crossword puzzle game in teaching because it will help to enhance students' acquisition of problem solving abilities, and thus improve achievement.

***Key words*:** crossword puzzle game, academic achievement, chemistry, secondary school.

Introduction

The growth of any nation depends on her scientific advancement. The issue of scientific and technological advancement has been on a very slow pace in Nigeria because scientific advancement cannot take place in the absence of a sound science education. This is because the development of any nation, which depends on science and technology, completely hinges on the nation's science education (Moore & Dettlaf, 2010). Science education is a distinct form of creative human activity which involves distinct ways of seeing, exploring and understanding reality. Therefore, chemistry as one of the core science education courses is highly required for the effective growth and development of a developing nation like Nigeria.

Chemistry has a very important role to play in the industrial growth of any nation. In Nigeria, the knowledge acquired from chemistry has become a major source of technological and socio-economic development stemming from the processing of petroleum and petrochemical products for industries. Chemistry education equips the learner with specific knowledge; skills and attitude which enables him/her become useful to him/herself and the society at large, (Njoku, 2007). Little wonder then, that for instance in Nigeria, a credit pass in chemistry in secondary school is a pre-requisite for students to further their studies in fields like medicine, pharmacy, agriculture, engineering, and other related fields of endeavour. The effective learning of chemistry in senior secondary schools therefore becomes desirable.

However, in spite of the enormous role that chemistry plays in national development and the efforts of government and other stake holders in improving chemistry education in Nigeria, chemistry results in most certificate examinations like those of the West African Examination Council (WAEC) and National Examination Council (NECO) have not been satisfactory(Onuekwusi, 2011).Teachers also complain of low enrolment, students' low achievement at both internal and external examinations (Ayo-Vaughan & Amosun, 2016). Regrettably what makes the whole system unacceptable is that understanding of chemistry is a challenge to students. Many students hardly make good grades in chemistry in the Senior Secondary School Certificate Examination (SSCE) conducted by the West African Examinations Council (WAEC) and the National Examinations Council (NECO), as well as in the Unified Tertiary Matriculation Examination (UTME). This ugly situation has created a big doubt on the possibility of Nigeria growing in the area of technological advancement and health, like other developing countries of the world.

Some problems were identified as reasons behind this ugly trend. These factors among others include poor quality school science teachers and utilization of inappropriate teaching methods in schools (Ayo-Vaughan & Amosun, 2016). Chemistry teachers in secondary schools

have been teaching chemistry using conventional methods such as lecture method, expository, discussion, project and demonstration to ensure that the subject is well taught and comprehended by their students. Despite the application of these methods, students have not really been performing up to expectations (Okoli 2006; Okeke 2014). This could be because conventional method does not really give students the opportunity to participate actively during teaching and learning, hence they become passive listeners during lessons making the students see chemistry as an abstract subject (Uwaleke, Offiah & Okechukwu, 2014). It is therefore crucial that teachers should make efforts to employ innovative instructional techniques that are capable of enhancing achievement and improve the quality of teaching and learning of Chemistry. Since Chemistry is a practical oriented subject, students' active involvement in the subject needs to be encouraged by teaching it through activity-based method(Alaribe, 2010). These activities include touching, seeing, feeling, demonstrating, manipulating, playing of game and all kinds of puzzle, and other activities in the classroom. Similarly, a number of authors (Njoku 2004; Onuekwusi, 2004; Onwukwe, 2011) have identified gender as a significant variable in students' achievement in the sciences and chemistry in particular amongst students. However, Odutuyi (2014) have an opposite view, saying that it was the methods used by the teachers that bring about low achievement, not gender. Hence better pedagogical approaches to teaching and learning of chemistry needs to be investigated in order to overcome the challenge of low achievement in chemistry amongst secondary school students.

In the WAEC Chief Examiner's Report (2018), it was suggested that students' achievement in chemistry could be improved through meaningful and proper teaching technique which can be related to real life situations. According to the report, teachers should help students build the requisite innovative and technical knowledge like the use of crossword puzzle game in chemistry by reducing the rate of teaching the subject theoretically. It therefore

becomes imperative to look for interventions that could be put in place to improve learning outcomes. This could help enhance students' achievement in chemistry in secondary schools.

Furthermore, studies conducted by researchers like, Kirikkaya, Iseri and Vurkaya (2010) and Olanguju, & Babayemi, (2014) has shown that some relationship exists between students' application of crossword puzzle game when different techniques are used, although their studies were in physics, basic science and mathematics at the tertiary level. The researcher is not aware of any current attention directed towards ascertaining the effect of crossword puzzle game on students' academic achievement especially at the secondary school level and Awka Education zone of Anambra state, Nigeria.

This study is focused on the effect of Crossword puzzle game on secondary school students' academic achievement in chemistry to ascertain its great contribution in solving the problem of low achievement by students in chemistry. Crossword puzzle game is used as an advance organizer in this study.

An advance organizer is an instructional tool for teachers to help students understand, retain, remember new learning material and make connections between one concept and another. An advance organizer is used to introduce the lesson topic and illustrate the relationship between what the students are about to learn and the information they have already learned. Advance organizers are used during expository instruction, whereby information is presented in a way that makes it easy for students to make connections from one concept to the next. By using an advance organizer to link the new information to old information, the new information can be remembered more easily. According to Githua (2008), there are three basic purposes of advance organizers. First, they direct students' attention to what is important in the upcoming lesson. Second, they highlight relationship among ideas that will be presented. Third, they remind students of relevant information that they already have. A typical way of

employing an advance organizer in the classroom is the introduction of games in the lesson. In this study, the crossword puzzle game was used.

A game is a form of competitive activity or sport played according to rules. It is a structured form of play, an art in which participants called players, make decisions in order to manage resources through game tokens in the pursuit of a goal. It is a system which players engage in an artificial conflict, defined by rules, and result in quantifiable outcome. In response to different teaching methods, the use of games in the classroom can be an effective tool, especially at secondary school level. Gifted and talented students, who are present almost in every class, have been found to prefer games and other alternative teaching methods (Moore & Dettlaff, 2010).In the view of Umoru & Ubom (2013)games can add flexibility to the classroom, allowing students to adjust to the way in which they learn best; can be used to complement the traditional methods; allow students to work in groups or alone, to be competitive, and creative, and to have fun while learning. Educational games have inherent potential to: excite learners, generate new ideas in learners, teach difficult science concepts, remove fatigue, and foster social interactions.

With these benefits in mind, the crossword puzzle stands out from the rest of games as a classroom tool. Crossword puzzles are word puzzles that normally takes the form of a square, rectangular or diagonal grid of white or blank and shaded squares. The goal is to fill the blank squares with letters forming words or phrases by solving clues which lead to the answers. In a language which is written from left to right, the answer words and phrases are placed in the grid left to the right and from top to bottom. The shaded squares are used to separate the words or phrases; squares in which answers begin are usually numbered, the clues are then referred to by these numbers and with direction. According to the American Heritage Dictionary of the English Language (2009), crossword is a puzzle which contains an arranged number of squares.

The goal is to fill in the white squares with letters both horizontally and vertically (across and down), even diagonal, in relation to numbered clues (the definitions).

Furthermore, crossword puzzle is a useful tool when students get familiar with them, as it reduces the need to explain directions; it saves class time and these puzzles are often perceived as being a recreational activity, therefore making it more enjoyable and less threatening than conventional method, (Wersskirch, 2006). Therefore, the use of games (crossword puzzle) in teaching and learning of chemistry could immensely enhance students' academic achievement in chemistry. It is on this premise that this study sought to investigate effects of the use of advanced organizer (science crossword puzzle) on students' academic achievement.

Evidence from studies in Nigeria shows that exposure to games and puzzles are effective in enhancing students' academic achievement in Basic Science (Babayemi and Olangunji 2014). It was also found that crossword puzzle game -based instructional intervention on the learning outcomes of low performing senior secondary students in Nutrition course yields better academic achievement of SSI students than exposure to conventional method (Yien, Hung, Hwang, and Lin, 2011). Although these studies are related to the present study in terms of exposure to the use of crossword puzzle games but they are different in terms of location, design and focus. This study investigated the effect of crossword puzzle games on students' academic achievement in chemistry.

Purpose of the Study

Specifically, the objectives of the study were to determine the difference in the mean achievement scores of students exposed to chemistry crossword puzzle game (CCPG) as advanced organizers and those taught with conventional method using their pre-test post-test scores; determine the difference in the mean achievement scores of male and female students exposed to chemistry crossword puzzle game; find out the interaction effect of gender and

teaching method on students' achievement as measured from the Chemistry Achievement Test (CAT).

Research Questions

The following research questions guided this study.

1. What is the difference in the mean achievement scores of students exposed to chemistry crossword puzzle game and those taught with conventional method using their pre-test post-test mean scores?
2. What is the difference in the mean achievement scores of male and female students exposed to chemistry crossword puzzle game?

Research Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference between the mean chemistry achievement scores of students exposed to chemistry crossword puzzle game and those taught with conventional method using their pre-test post-test mean scores.
2. There is no significant difference between the mean chemistry achievement scores of male and female students exposed to chemistry crossword puzzle game and those taught with conventional method using their pre-test post-test mean scores.
3. There is no significant interaction effect of gender and teaching method on students' achievement as measured from the Chemistry Achievement Test (CAT).

Method

The study adopted a quasi-experimental research design which was focused on Senior Secondary School (SSI) chemistry students from Government owned coeducational secondary schools in Awka Educational Zone of Anambra state, Nigeria. It was aimed at determining the effect of crossword puzzle game on SSI chemistry students' academic achievement in

chemistry. Population of the study comprised all the 1,011 SSI students in the 15 government owned coeducational secondary schools in Awka Education Zone. A sample of 139 SSI chemistry students were from two schools that were randomly selected from the 15 government-owned secondary schools in the zone. Chemistry Achievement Test(CAT) was the instrument used for data collection which was validated by three experts from chemistry, science education and education measurement and evaluation. The CAT was designed to measure the extent of students' achievement in chemistry. The CAT comprised twenty multiple choice questions drawn from past questions of West African Senior School Certificate Examination. Table of specification was used to determine the lower and higher cognition measured in the pool of 20 multiple choice objective test items which were used as CAT. The marking scheme for the CAT was also developed and each question correctly answered attracted five marks. The reliability of the CAT was established using Kuder- Richardson Formula 20 (KR) with a sample of 40students outside the study area. The reliability co-efficient was 0.72 which is considered high.

The experimentation involved exposing the experimental and control groups to the chemistry concepts using their conventional approach. The experimental group was further exposed to chemistry cross-word puzzle simultaneously for each lesson content taught. Before the crossword puzzles are given, the researcher ensured that students took lessons on the concepts. The experimental treatment therefore served as an addition to the class teacher's lessons on the topics.

The treatment proceeded are as follows: week 1): The researcher spent the first week to identify, familiarize and train effectively the in-service teachers who served as research assistants for the experimental group. Week 2): students were introduced to the concept of matter. Twenty-four (24) crossword puzzles on matter and changes of state was printed and

given to each student with the directives. The students were divided into five groups which included competition and group discussion among the groups. After the exercise, the teacher offered correction to all the questions. After the first crossword puzzle, another crossword puzzle was given to the students containing 7 vertical and horizontal cells. The students attempted this puzzle on their own and shared the answer with the class on the teacher's appointment. Another seven question crossword puzzle on the states of matter was given the students again to expose them more to the concept of matter and changes in state. For week 3, crossword puzzle games on atoms and molecules was given to the students to be answered following the teacher's guidance. After the first 21 crossword puzzle game, another 15 crossword puzzle was given the students still on atoms and molecules but delving into component particles of atom and their properties. The lesson was concluded with another 7 question crossword puzzle game on common molecules and their names. In weeks 4 and 5, elements and symbols were treated and stronger crossword puzzles were introduced. To enhance the puzzles, the cells of the crossword puzzle given to the students were shaded and the number of crossword increased to 35 across the puzzle and 33 down the puzzle. The crossword puzzle was designed on symbols, elements, names of the first twenty elements. Another challenging crossword puzzle on the periodic arrangement of the elements in the periodic table was introduced after this and answered along with the teacher. To end the lesson, crossword puzzle on the symbols of elements was given to the students to answer on individual note before discussion.

During each lesson, a print-out of the crossword puzzle and the directives were made available to each student. Students were allowed to consult with those in the group they are assigned before giving any answer to the crossword puzzles on their paper. After each lesson, the teacher summarized the important concepts taught and evaluated the lesson by asking the students questions relating to the concepts treated in the crossword puzzle games.

The control group was taught the same concepts as the experimental group without the use of science crossword puzzles. Thus, both the experimental and control group were taught using the conventional methods, but the experimental group received their lessons simultaneously with crossword puzzles. The exercise lasted for six weeks.

At the end of the six weeks teaching exercise all the students in the two intact classes (experimental and control groups) were tested immediately after the treatment. The researcher collected the instrument at the end and the scores obtained from the two groups were used to determine whether there was a significant difference in students' taught chemistry with the exposure to crossword puzzle games and those taught without it. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypothesis at 0.05 levels of significance.

Result

Table 1: ***Difference in Mean Achievement Scores of Students Exposed to chemistry using Chemistry Crossword Puzzle Game and Conventional method***

Group	N	Pre-test $\overline{x}$	SD	Post-test $\overline{x}$	SD	Gain in Mean
Experimental (SCPG)	65	37.8	16.7	68.8	16.7	31.0
Control (lecture method)	74	28.7	18.5	44.0	20.1	15.3

The analysis on Table 1 shows the pre-test and post-test mean achievement of students exposed to CCPG (37.8; 68.8) and those taught with lecture method (28.7; 44.0) in Chemistry. The analyses further revealed that mean post-test achievement scores of students exposed to CCPG (68.8) is higher than that of the students taught with lecture method (44.0). This shows that CCPG is effective in enhancing students' achievement in chemistry

Table 2: ***Difference in Mean Achievement Scores of Male and Female Students Exposed to CCPG***

Group	N	Pre-test		Post-test		Gain in
		$\overline{x}$	SD	$\overline{x}$	SD	Mean
Male	24	37.9	15.2	71.7	13.5	33.8
Female	41	37.8	17.6	67.1	18.4	29.3

Result on Table 2 shows the pre-test and post-test mean achievement scores of male and female students exposed to CCPG in Chemistry. The analysis also revealed that mean achievement scores of male students exposed to CCPG is higher than that of their female counterparts exposed to CCPG in Chemistry.

Table 3: ***Tests of Between-Subjects Effects of Mean Achievement Scores of Students Exposed to CCPG and that of those taught with Conventional method in Chemistry***

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	25857.987[a]	2	12928.993	40.887	.000
Intercept	62517.319	1	62517.319	197.705	.000
Group	15443.146	1	15443.146	48.837	.000
Pre-test CAT	4548.534	1	4548.534	14.384	.000
Error	43005.251	136	316.215		
Total	498629.000	139			
Corrected Total	68863.237	138			

p < 0.05

The analyses on Table 3 reveal that test mode effect on achievement is significant given that $F_{(1,136)} = 48.837$, and $p < 0.05$ ($.000 < 0.05$). Therefore, the null hypothesis is rejected, thus, the difference in the mean achievement scores of students taught with CCPG and those taught with lecture method is significant. The mean achievement score of students exposed to CCPG is higher than those taught with lecture method in Chemistry.

Table 4: ***Tests of Between-Subjects Effects of Mean Achievement Scores of Male and Female Students Exposed to CCPG in Chemistry***

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1046.818[a]	2	523.409	1.912	.156
Intercept	39132.069	1	39132.069	142.961	.000
Gender	306.216	1	306.216	1.119	.294
Pre-test CAT	737.488	1	737.488	2.694	.106
Error	16970.967	62	273.725		
Total	325829.000	65			
Corrected Total	18017.785	64			

p > 0.05

Table 4 reveals that $F_{(1,62)} = 1.119$, and $p > 0.05$ (.294 > 0.05), this implies that gender effect on achievement of those exposed to CPCG is not significant. Therefore, the null hypothesis is not rejected, thus, the difference in the mean achievement scores of male and female students taught with exposure to CCPG in Chemistry is not significant**.**

Table 5: ***Interaction Effect between Gender and Teaching Method on Students' Achievement in Chemistry***

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	26224.894[a]	4	6556.224	20.604	.000
Intercept	62847.189	1	62847.189	197.511	.000
Pre-test CAT	4583.430	1	4583.430	14.404	.000
Group * Gender	54.931	1	54.931	.173	.678
Error	42638.343	134	318.197		
Total	498629.000	139			
Corrected Total	68863.237	138			

p > 0.05

Data as presented on Table 5 show that interaction effect between gender and teaching method on students' achievement in Chemistry is not significant based on the fact that $F_{(1,134)} = 14.404$, and $p > 0.05$ (.678 > 0.05). The null hypothesis is therefore not rejected.

Discussion

The finding of this study shows that there is a significant difference between the mean academic achievement scores of chemistry students exposed to CCPG and lecture methods in favour of CCPG group. Students' academic achievement in chemistry increased when exposed to CCPG and lecture methods as can be seen in their respective pre-test and post-test mean scores. This implies that CCPG method of instruction was found to be more effective on secondary school chemistry students' academic achievement than the lecture method. The finding of this study corroborates the findings of Fatokun, Egya and Uzoechi (2016) in a study on the effect of teaching periodicity with puzzle games on chemistry students' achievement and retention. The result revealed that the group taught periodicity using periodicity games and puzzles had a higher achievement and retention score than those taught with the lecture method. Furthermore, Ayo-Vaughan and Amosun (2016) found significant differences on school age children's civic competence with the puzzle-based games strategy enhancing their civic competence better than the conventional method.

The finding reveals that the mean achievement scores of male students exposed to CCPG was higher than that of female students exposed to CCPG. Nevertheless, the difference in the mean achievement scores of male and female students exposed to CCPG was not significant. Also, the mean achievement scores of male students taught with lecture method were higher than their female counterparts taught with lecture method. However, the difference in the mean achievement scores of male and female taught students with lecture method was not significant. The above finding is in agreement with the findings of Olanguju, and Babayemi, (2014) and Gallagher, Bridgeman and Calahan (2002) as well as Lesson (2006) who found that male examinees performed better on the CCPG format than female examinees who showed slightly poorer performance on CCPG. More so, a number of studies have found that

boys outperform girls when tested on the crossword puzzle, while girls perform significantly better on conventional tests (Csapó et al., 2009; Lee, 2009)Researchers have hypothesized several reasons for this finding. Some suggest that although gender gaps in volume of computer usage have closed rapidly over the last few years, boys are much more likely to play online games and use game-type software that are similar to the crossword based test items.

The study revealed that the interaction effect of gender and teaching method on students' achievement in Chemistry is not significant. The result of this study supports the findings of Fatokun, Egya, and Uzoechi (2016) that there is no significant interaction effect of gender and teaching method as measured from the PAT was found. The researchers concluded that there is a significant difference in the achievement of SS2 students taught periodicity using game method and those taught with lecture method. They also noted that there is no gender disparity in the achievement and retention of concept learnt by those students taught periodicity with games method. In addition, Ayo-Vaughan and Amosun (2016) found no significant interaction effect of gender and treatment method based on the achievement of the students. The researchers concluded that puzzle games strategy has better potentials at enhancing school age children civic competence better than the case study or lecture method. Also, Babayemi and Olagunju (2014) found that interaction effect of gender and teaching methods was not significant. The researchers concluded that Crossword-Picture Puzzle-Based teaching strategy was more effective than the lecture method in improving students' attitude to Basic Science

Recommendations

1. Chemistry teachers should use crossword puzzle game in teaching secondary students; this ensures students active participation and thus, enhances academic achievement in Chemistry.

2. Curriculum planners and stake holders in education should make and implement policies that will ensure that secondary schools incorporate CCPG method in classroom teaching for better students' academic achievement.

Conclusions

The study has revealed that the use of CCPG approach significantly enhances chemistry students' academic achievement than conventional method.

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Effect of Scaffolding Instructional Strategy on Secondary School Students' Achievement in Biology in Onitsha Education Zone in Anambra State

Pat-Anyaeji, V. N.
Anambra State College of Health Technology, Obosi, Anambra State, Nigeria
&
Okeke, S. O. C.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
soc.okeke@unizik.edu.ng

Abstract

Effect of scaffolding instructional strategy on secondary school students' achievement in biology in Onitsha education zone of Anambra state was investigated. Two research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The quasi-experimental design, specifically the pre-test post-test non-equivalent control group design was adopted. The population of the study was 4,724 SS2 biology students in Onitsha Education Zone, of Anambra state. A sample of 154 SS 2 biology students obtained using a multi-stage procedure was involved in the study. The instruments for data collection was Biology Achievement Test (BAT) validated by two lecturers in Departments of Science Education and Educational Foundation, from Nnamdi Azikiwe University, Awka and one experienced secondary school biology teacher. The reliability of the instruments was established using Kuder-Richardson Formula 20 to be 0.61. The experimental group was taught biology using SIS while the control group was taught using conventional method. Data were collected by administering the instruments as pre-test and post-test before and after treatment. The data obtained were analysed using mean and standard deviation to answer the research questions and analysis of covariance was used to test the hypotheses. The findings of the study revealed that scaffolding instructional strategy significantly enhanced the achievement of both male and female students in biology. The conclusion was that scaffolding instructional strategy positive enhances achievement in biology. The study recommended among others that biology teachers should acquaint themselves with the various scaffolding strategies and integrate them in their biology lessons.

Keywords: Scaffolding, biology, achievement, hereditary, gene transfer

Introduction

Biology plays an important role in the understanding of complex forms of life involving humans, animals and plants. It is important to study biology in secondary schools because it helps to get a better understanding of the world in its natural processes and in creating a better environment to live in among others. Inspite of this importance and popularity of biology among Nigerian students, students' achievement in the subject at senior secondary school level has been persistently poor. Analysis of students' achievement in West African Examination

Council (WAEC) Biology shows that the percentage number of students' who made credit pass (A1-C6) which is the minimum requirement for admission into higher institution has been fluctuating. Students' overall performance indicated as raw mean scores by the WAEC Chief Examiner, was not encouraging. The students' achievement in biology from 2016 to 2017 showed a decline in achievement. In 2018, it can be seen the students' achievement in paper two was less compared to the two past years. In the past years, the situation is abysmal to the extent that the achievement of students in the West African Senior Secondary School Certificate Examination in biology remained poor. In recent times therefore, these poor academic achievement conditions have not improved. The issue of poor achievement in biology therefore has become of interest to many researchers.

Academic achievement is the performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college and university (Ricarda, Anja, Anne & Linda, 2017). Factors that may be attributed to the poor achievement of students in biology include; unqualified teachers, lack of instructional materials, lack of educational facilities like laboratories and teaching methods (Daworiye Alagoa, Enaregha & Eremasi, 2015). The emphasis on teaching method as reported in many studies implies the need for more innovative teaching methods that can enhance understanding, achievement and interest. One of the ways of enhancing students' interest and achievement in biology as suggested by Sakiyo and Badau (2015) is for the teacher to provide a bridge between unfamiliar concepts and knowledge which students already have. Such innovative method of teaching that holds promises of sustaining interest and boosting students' achievement is scaffolding instruction.

The introduction of instructional scaffolding as a teaching technique can be traced to the work of Soviet psychologist, Lev Vygotsky's (1978) socio cultural theory and the concept of Zone of Proximal Development (ZPD). ZPD is that field between what a learner can do by

himself (expert stage) and what can be achieved with the support of a knowledgeable peer or instructor (pedagogical stage).Instructional scaffolding is the support and assistance given in any learning situation where the teacher provides temporary support structure that will assist the learners to develop new understanding, skills, concept and abilities (Nzewi & Ibeneme, 2011). As a learner gains control of these new learning, the teacher withdraws the support gradually while the learner becomes increasingly able to complete the task alone. The teacher then plans and provides further support on new learning. Such support structures could help the learner to complete a task using cueing questions, discussions, concept maps, prompts, advanced organizers, video tapes or explanations. Scaffold is a framework which students lean on in order to achieve a targeted academic goal (O'Toole & Plummer, 2004).

The metaphor of scaffolding has been applied to a number of learning areas. Major report from the studies involving the use of scaffolding instructional strategy is that instructional scaffolding boosts achievement in learning (Aditi, 2017; Alake, 2013;Alibali, 2006; Casem, 2013; Kim, 2007; Omiko, 2015; Uduafemhe, 2015; Williams & Tiering, 2008). Although instructional scaffolding have been widely studied for a while, it interpretation and application in the classroom remains vague. While most of the studies on instructional scaffolding used cues, task prompts, concept maps and graphics, little is known about the use of the combination of conversational cues and task prompts. Due to its diverse interpretations, scaffolding does not provide educators with clear and definite guidelines on the ways that it should be used to achieve successful teaching. Piaget's view of the child as active constructor of their own knowledge is regarded as his greatest contribution to the theory of child development (Berk 2002; Krause, Bochner & Duchesne, 2003; McDevitt & Ormrod, 2002). Piaget proposed a new vision of learning where the traditional educational instruction, given to students by adult in a direct way should be replaced by a child-centred curriculum, where the emphasis is placed on the initiative and independent discovery of the child as a self-

determined learner. This view of learning is based in child's natural interest and motivation to learn which should be supported in the classroom if we want the children become self-motivated lifelong learners. Traditional direct instructions such as conventional method will therefore be compared with scaffolding in this study.

Conventional method of teaching is the teacher's usual way of teaching which can take the form of a lecture recitation to full-class with explanation, examples, and opportunities for practice and feedback (Ellect, 2007). Its format is a multifaceted presentation requiring not only large amount of verbal explanation but also teacher-student interactions involving questions, answers, review and practice and the correction of students' errors (Dunne & Kim, 2004). Conventional method is also used when the teacher must achieve content mastery of fundamental facts, rules, and action sequences that may be essential to subsequent learning to enhance achievement irrespective of gender.

Gender is any physical and behavioural difference between males and females which are socio culturally based. There is always the participation of male and female students in any academic setting such as science. This brings the issue of gender to educationist and researchers because there is bound to be interaction between male and female students in the cause of learning. Both male and female students study biology in secondary schools and it is reasonable to determine differences in biology achievement of male and female students using scaffolding instructional strategy.

Purpose of the Study

The purpose of the study was to investigate the effects of scaffolding instructional strategy on secondary school students' achievement and interest in biology in Onitsha Education Zone. Specifically, the study determined the:

1. Difference in the mean achievement scores of students' taught biology using scaffolding instructional strategy and those taught using conventional method.

2. Difference between the mean achievement scores of male and female student.
3. Interaction effect of teaching methods and gender on students' achievement in biology.

Research Questions

1. What are the mean achievement scores of SS2 students taught biology using scaffolding instructional strategy (SIS) and those taught using conventional method?
2. What are the mean achievement scores of male and female students taught biology using SIS?

Hypotheses

1. There is no significant difference in the mean achievement of students taught biology using SIS and those taught using conventional method.
2. There is no significant difference between the mean achievement scores of male and female students taught biology using SIS.
3. There is no significant interaction of teaching methods and gender on the achievement of students in biology.

Method

The design of the study is quasi-experimental, specifically, the pre-test post-test non-equivalent control group design. The area of study was Onitsha Education Zone of Anambra State. The population of the study comprised 4,724 (2333 males and 2391 females) senior secondary school year two (SS 2) biology students in 32 secondary schools in Onitsha Education Zone of Anambra State. The sample size for the study was 154 (77 males and 77 females) SS 2 biology students. The sample was obtained using multi-stage sampling procedure. First, secondary schools in Onitsha Education Zone were stratified according to the three Local Governments Areas in the Zone (Onitsha North, Onitsha South and Ogbaru).Using random sampling (balloting without replacement) two out of the three local government areas

(LGA) were selected. In each LGA, the co-educational schools were listed out and random sampling was used to select two schools, one from each LGA. Biology students in one intact class from each of the two schools were randomly assigned to experimental and control groups respectively. The experimental group has 83 students (41 males and 42 females) while the control group has 71 students (36 males and 35 females).

The instrument for data collection was Biology Achievement Test. The BAT consisted of 50 items taken from past WAEC question and answers booklet (Anyaele, 2017). Table of specification was used to determine adequacy of questions in each content area taught. The BAT was on the concept of genetics, cells and variation and was also designed to generate information about the students' demography. Lesson plans were also developed for the treatments. The BAT was validated by two lecturers in the Departments of Science Education and Educational Foundations, Nnamdi Azikiwe University, Awka and one experienced secondary school biology teacher. The reliability of BAT was established using Kuder-Richardon-20 Formula (KR-20). The instrument was administered once to 40 students in a Community secondary school in Nnobi (Ogidi Education Zone). The generated scores were tested for reliability co-efficient by applying the KR-20 Formula. The coefficient of internal consistency obtained for BAT was 0.61.

The experiment was carried out in two phases. The first phase was the training of the research assistants and the second administration of treatments. The training of the two research assistants who are the regular biology teachers in the school used for experimentation was done in one week, three contacts and 2 hours per contact. The treatment in phase II involved teaching the experimental group using instructional scaffolding specifically through the use of conversational cues while the control group was taught using conventional method. Before the commencement of the treatment, both the experimental and control groups were administered with a pre-test. There was no correction to the pre-test and the students were not given any

feedback on the pre-test. After the pre-test, the experimental group was exposed to the concepts of genetics, variation and cells using instructional scaffolding. The type of scaffolding that were used is conversational cues and task prompts.

The control group was exposed to the same concepts using conventional method. At the end of the experiment, both groups were administered with a pre-test using the BAT and BIS.

Mean and standard deviation were used to answer research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. The decision rule was reject null hypothesis where P-value is less than 0.05, otherwise, do not reject.

Results

Table 1: Mean Achievement Scores of Students in Biology Taught Using Scaffolding Instructional Strategy and those taught Using Conventional Method

Group	N	Pre-test Mean	Post-test Mean	Gained Mean	Pre-test SD	Post-test SD
SIS	83	23.01	69.08	46.07	2.53	2.47
Conventional	71	22.23	48.82	26.59	2.59	4.38

Table 1 reveals that the students taught biology using SIS instruction had pre-test mean achievement score of 23.01 and post-test mean achievement score of 69.08 with gained mean achievement score of 46.07, while those in the control group taught with conventional method had pre-test mean score of 22.23 and post-test mean score of 48.82 with gained mean 26.59. The use of SIS reduced the variation of score from 2.53 in the pre-test to 2.47 in the post-test, whereas conventional method increased the spread of score from 2.59 in the pre-test to 4.38 in the post-test.

Table 2: Mean Achievement Scores of Male and Female Students Biology taught using SIS

Gender	**N**	**Pre-test Mean**	**Post-test mean**	**Gained Mean**	**Pre-test SD**	**Post-test SD**
Male	41	21.62	59.64	38.02	2.01	4.91
Female	42	23.68	59.84	36.16	2.16	4.11

Table 2 shows that male students taught using SIS had a gained mean achievement score of 38.02 while the female had pre-test mean score of 36.16. The use of SIS resulted in more increase in the spread of scores among male students than among the female students.

Table 3: ANCOVA Test of Significant Difference in Mean Achievement Scores of Students taught Biology using SIS and Conventional Method

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	15742.035[a]	4	3935.509	322.978	.000	
Intercept	6748.414	1	6748.414	553.826	.000	
Pre-test	23.320	1	23.320	1.914	.169	
Gender	.087	1	.087	.007	.933	NS
Method	1596.731	1	1596.731	131.040	.000	S
Method * Gender	.009	1	.009	.001	.978	NS
Error	1815.575	149	12.185			
Total	567168.000	154				
Corrected Total	17557.610	153				

Table 3 shows that at 0.05 level of significance, 1df numerator and 153df denominator, the calculated F is 131.040 with P-value of .000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, there is significant difference in the mean achievement of students in biology taught using SIS and those taught using conventional method in favour of SIS.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 153df denominator, the calculated F is .007 with P-value of .933 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, there is no significant difference between the mean achievement scores of male and female students in biology.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 153df denominator, the calculated F is .001 with P-value of .978 which is greater than 0.05. Therefore, the null hypothesis five is not rejected. Thus, there is no significant interaction of teaching methods and gender on the achievement of students in biology.

Discussion

The findings of research question one revealed that scaffolding instructional strategy significantly enhanced the achievement of students in biology. In scaffolding, the support and guidance provided to learners facilitate internalization of the knowledge needed to complete the task. This is why proper learning took place among students taught using scaffolding instructional strategy. Because learning took place in the learner's zone of proximal development, they came to understand and accomplish tasks with little assistance. The improvement in learning and achievement could be attributed to the fact that that individuals learn best when working together with others during joint collaboration, and it is through such collaborative endeavours with more skilled persons that learners learn and internalize new concepts.

In scaffolding, because the teacher needs to anticipate errors the learners are likely to commit when working on the task and properly guide the learners away from ineffective directions, students' understanding improved. Students therefore, work with focus about what they need to learn or about what they are to do. The students' interaction with the learning material is also one of the contributors to the observed improvement in academic achievement. This finding is line with the findings of Nonye and Nwosu (2011) that instructional scaffolding method was superior to the conventional method in improving the achievement of students. The finding is also in line with the findings of Nzewi and Ibeneme (2011) that in all categories of students cueing questions used as scaffolds significantly improved achievement more than the conventional method. It also supports the finding of Alake and Ogunseemi (2013) that students exposed to scaffolding strategy performed significantly better than their counterparts who were exposed to traditional method.

The findings of research question two showed that there was no significant difference in the achievement of male and female students. There was no significant interaction effect of

teaching methods and gender on the achievement and interest of the students. This could be attributed to the fact the use of instructional scaffolding allows the students both male and female equal opportunity to learn at their own pace and to learn according to their ability. Thus, scaffolding instructional strategy uniformly improved achievement and interest in biology. The finding of the study is line with the findings of Orjika (2012), that effect due to gender relative to teaching method did not differ significant for male and female students. The findings of the study also lend support to the findings of Efe (2015) that no significant difference was found between the mean achievement of male and female students.

Conclusion

It can be concluded from the findings of the study that the adoption of scaffolding instructional strategy by biology teacher could result in the improvement of students' achievement in biology. The method also can positively affect male and female students' achievement in biology.

Recommendations

1. Biology teachers should use scaffolding instructional strategy when necessary to ensure active involvement in the lesson and improved achievement.
2. Seminars and workshops on how to use scaffolding instructional strategy to teach biology should be organized by the government for biology teachers.
3. Biology teachers should acquaint themselves with the various scaffolding strategies and how to integrate them in their daily biology lessons.

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Effects of Projected Video Package Instruction on Secondary School Students' Achievement in Computer Studies in Onitsha Education Zone, Anambra State

[1]Anaehobi, C. C., [2] Offiah, F.C. & [3] Okigbo, E. C.

[1] Anambra State College of Health Technology, Obosi, Anambra State, Nigeria
[2,3]Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
[1]chizube@yahoo.com [2]fc.offiah@unizik.edu.ng [3]ec.okigbo@unizik.edu.ng

Abstract

The study investigated the effect of projected video package (PVP) instruction on secondary school students' achievement in computer studies in Onitsha Education Zone of Anambra State. Two research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The quasi-experimental design specifically, the pre-test post-test non-equivalent control group design was used. The population of the study comprised 4,526 senior secondary school year two (SS2) computer studies students in the area of study. A sample of 121 SS2 computer studies students obtained through a multi-stage sampling procedure was involved in the study. The instrument for data collection was Computer Studies Achievement Test (CSAT) validated by two experts in Nnamdi Azikiwe University, Awka and one experienced computer studies teacher. The reliability of the instrument was established using Kuder-Richardson formula 20 which yielded coefficient of internal consistency of 0.89. The experimental group was taught using PVP while the control group was taught using conventional method. Data obtained were analysed using mean and standard deviation to answer the research question while Analysis of Covariance (ANCOVA) was used to test the hypotheses. The findings showed that there was significant difference in the mean achievement scores of students taught using PVP and conventional method in favour of the PVP. The study recommended among others that computer studies teachers should use PVP instruction in the teaching and learning of computer studies.

Keywords: Projected video, computer, achievement, computer appreciation, applications

Introduction

In the world today, it is almost impossible to imagine that someone can live without computers. Computers have become an electronic gadget of almost everyday use for individuals of every age, and essential in almost all the business dealings that are made nowadays. In recent years computers and their accompanying accessories have gained significance as they have improved the efficiency and productivity of work done (Staniger, 2014). Large amounts of information in industrial and business sectors as well as personal lives

of individuals are stored on servers. In view of the importance computers, computer education was introduced in secondary school and widely called Computer Studies.

Computer studies deals with the study of computer systems and their application in solving the problems of everyday living. It deals with the scientific and practical approach to computation and its applications and the systematic study of the feasibility, structure, expression, and mechanization of the methodical procedures (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information (Eden, 2007). A computer scientist specializes in the theory of computation and the design of computational systems. It probes into computer appreciation which deals with the fundamentals of computer education and learning of application packages at the secondary school level. Computer studies is therefore more of a practical subject than theoretical. Owolabi and Ogini (2014) however, noted that there is a wide disparity between policy pronouncements and policy implementations in Nigeria. This is evident today in the level of computer literacy among secondary school students and their achievement in external examinations like West African Senior School Certificate Examination Council (WASSCE).

Academic achievement is the outcome of instruction which indicates the degree to which the instructional goals have been met (Hattie, 2009). Achievement may be measured through examinations or continuous assessment. When academic achievement is determined through examination, it denotes the extent to which students have met the goal or the objectives of instruction. Thus, students' achievement in external examination is a good source of information about their academic achievement.

Students' performance according to the WAEC Chief Examiners report (2014) for computer studies students was fairly well though there was no basis for comparison with any other previous performances. The Chief Examiner, however, reported some common weakness with majority of the candidates such as: poor understanding of acronyms, basic programming

and inability to use keywords in defining terms. Consequently, the Chief Examiner suggested that students be exposed to more laboratory sessions to enable them develop content; that the subject be handled by qualified and well-motivated teachers; and that efforts should be made to expose the students to the basics, principles and theories of computer studies.

Based on recommendations of the WAEC Chief Examiner's Report in 2014, students' achievement in 2015 according to the Chief Examiners report was better than their achievement in 2014. The report noted that the students' strengths in terms of their responses revealed the desire and ability for computer studies as a subject and that students recorded better performance in the questions that were mostly recall type questions. Nevertheless, students showed weakness in defining operation system, misinterpretation of computer files as a database file, inability to differentiate between data and information, confusion between algorithm and flowchart. Other weaknesses include poor handwriting, spelling mistakes and poor knowledge of computer keywords.

In the communiqué issued at the Nigerian Examination Committee (NEC) meeting on 2016 WAEC results, the Chief Examiner noted the following general weaknesses of computer studies candidates such as: spelling errors, illegible handwriting, inability to explain terms in computer studies and inability to correctly apply correct principles and input data in computers. The communiqué also implored state governments to take advantage of the training of secondary school teachers. The Chief Examiner however, recommended that computer studies instructors should identify the correct teaching methodology which will help the students to understand their weak areas better.

The students' weaknesses and the suggested remedies by both the committee and the Chief Examiner simply showed that the method adopted by teachers may not have been effective. Also, the teachers may also not have been vast in the use of innovative teaching methods especially those involving ICT in delivering the subject contents of computer studies

to secondary school students. The need, therefore arose to investigate the usage of some ICT equipment that is adaptable to the teaching and learning environments. This need is further underscored by the recent advancements in computer science especially in the areas of Information and Communications Technology (ICT) which bear the potential to improve students' achievement. It is assumed that the introduction of ICT in the process of instructional delivery of computer studies concepts may improve students' achievement in the subject.

The term ICT refers to the convergence of audio-visual and telephone networks with computer networks through a single cabling or link system. These developments in ICT have many applications in the classroom today. One of the ICT-based learning which is believed to hold beneficial boost for the students' achievement is the use of projected video packaged (PVP) instruction. According to Evey, Emmanuel, Joseph, Dennis and Asinde (2010) PVP instruction is an instructional delivery approach in which the teacher projects videos that can help students understand the contents of the lesson on a screen. This approach to instruction allows teacher to simulate the concepts taught, use many examples to facilitate lesson delivery through a video demonstration of the processes and concepts.

In this study, PVP involved projecting video files and simulation on the concept being taught. The teacher at various times and steps of the instruction displays the video to help students understand what was taught. The projected videos and simulations also formed the basis of interaction for the students. Studies in the areas of ICT-enabled learning revealed that it improved students' achievement in various subject area (Isiaka, Moses & Olumorin, 2013; Okoro & Ekpo, 2016; Omiola, Enuwa, Awoyemi, & Bada, 2012). Omiola et al. (2012) explained that the ability of PVP to improve students' achievement is because it offers students opportunity of learning with many senses. The use of PVP instruction appeals to the learner in various ways, arouses interest and motivation to learn. When compared with tradition methods of teaching like lecture method, PVP tend to engage the students actively. Although, the use of

PVP instruction requires serious planning and efforts on both teachers and students, it tends to facilitate proper conceptualization of concepts. Thus, PVP could improve learning and achievement more than conventional methods such as lecture which can be used to cover large content areas and for large number of students but does not engage the students' actively. The conventional method of teaching is quite often teacher centred but teachers need to adopt more students-centred approaches to learning like PVP which is innovative and has capacity to improve male and female students' achievement.

The issue of gender and its prediction of achievement in various subject areas have remained inconclusive. Killen (2007) averred that the cultural influence and setting of many Nigerian schools have facilitated this wide disparity in the achievement of male and female students. In addition, the approach to teaching and instructional materials adopted by science teachers sometimes favour certain sex over the other. For instance, Killen posited that the demands of exploratory learning in the field of science seem to favour more of the males than the females. Since, the use of PVP instruction engages the students actively, it is expected that it could enhance their achievement irrespective of gender, hence, the study also looked at gender influence on achievement when PVP is used for instruction.

Purpose of the Study

The purpose of this study was to investigate the effect of projected video package (PVP) instruction on secondary school students' achievement in computer studies in Onitsha Education Zone. Specifically, the study determined the:

1. Main effect due of instructional strategies on the achievement of students in computer studies.
2. Main effect due to gender on achievement of students in computer studies.
3. Interaction effect of instructional strategies and gender on students' achievement in computer studies.

Research Questions

1. What are the mean achievement scores of students taught computer studies using projected video package (PVP) instruction and those taught using conventional method?
2. What are the mean achievement scores of male and female students in computer studies?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught computer studies using PVP instruction and those taught using conventional method.
2. There is no significant difference between the mean achievement scores of male and female students in computer studies.
3. There is no significant interaction effect of instructional strategies and gender on the achievement of students in computer studies.

Method

The design for this study is the pre-test-post-test non-equivalent control group quasi-experimental design. The design of the study is as shown in Figure 1

$$\begin{array}{cccccc} E & 0_1 & X & 0_2 & 0_3 \\ \hline C & 0_1 & \sim X & 0_2 & 0_3 \end{array}$$

Figure 1: Design of the Experiment

Where,
E_1 = Experimental Group
C = Control group
0_1 = Pre-test
0_2 = Post-test
X_1 = Experimental treatment – Projected Video Package Instruction (PVP)
$\sim X$ = No experimental treatment – conventional method
--- = non-equivalence of the two groups

The area of the study is Onitsha Education Zone of Anambra State. The population of the study was made up of 4,526 (2287 male and 2239 female) senior secondary school two (SS2) computer studies students from 32 public schools in Onitsha Education Zone (Source:

Department of Planning, Research and Statistics, Post Primary Education Board, Onitsha, 2018). The sample size for the study was 121 SS2 computer studies students obtained using multi-stage sampling. Purposive sampling was used to first select from the three local governments in the Onitsha Education Zone those schools that are coeducational and which have the necessary ICT equipment required to conduct the study (laptop, desktop, projector, and generator set). This was because the coeducational schools helped to take care of the gender variable in the study. From the schools selected, balloting without replacement was used to select two schools. All the schools' names were written on pieces of paper to represent the population of coeducational schools and two schools were picked without replacement. The two schools were randomly assigned into experimental and control groups. In each of the schools those offering computer studies were used. The experimental group has 66 students (27 boys and 39 girls) whereas the control group has 55 students (22 boys and 33 girls).

The instrument for the study is a Computer Studies Achievement Test (CSAT) constructed by the researcher. The CSAT items were constructed based on two topics in computer studies (computer appreciation and word processing applications) as contained in the senior secondary school computer studies scheme of work. Also, instruction plans were developed by the researcher for the experimental and control groups. The instrument was validated by two lecturers, one each from Science Education and Educational Foundations Departments of Nnamdi Azikiwe University, Awka and one experienced computer studies secondary school teacher. Reliability of the instrument was established through a single administration to one intact class of 40 SS2 computer studies students in Ogidi Education Zone of Anambra state. The scores obtained were used to determine the co-efficient of internal consistency using the KR-20 Formula and coefficient of internal consistency 0.89 was obtained.

Data were obtained after treatment by administering the instrument as pre-test and post-test. Data relating to the research questions and hypotheses were analysed using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA). The decision rule for hypothesis was to reject the null hypothesis if P-value is lesser than 0.05, otherwise, do not reject the null hypothesis.

Results

Table 1: Mean Achievement Scores of Students' in Computer Studies taught using PVP and those taught using Conventional Method

Source of Variation	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
MII	66	18.86	65.91	47.05	7.88	9.11
DM	50	20.00	41.82	27.09	9.86	4.94

Table 1 reveals that the students taught computer studies using Projected Video Package (PVP) instruction had gain in mean achievement score of 47.05, while those in the control group taught with conventional method had gain in mean of 27.09. The group taught using PVP has higher score variation than the group taught using conventional method.

Table 2: Mean Achievement Scores of Male and Female Students' Achievement in Computer Studies

Method	Gender	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
PVP	Male	27	20.19	66.85	46.66	7.53	9.92
	Female	39	17.95	65.26	47.31	8.09	8.58
Conventional	Male	22	17.50	42.73	25.23	7.83	4.00
	Female	33	21.67	41.21	19.54	10.80	5.45

Table 2 indicates that male students taught using Projected Video Package (PVP) instruction had gain in mean achievement score of 46.66 while the female had gain in mean achievement score of 47.31. The variation of score was greater among the males than in the females in their post-test. Males taught using conventional method had gain in mean score of 25.23 while females had 19.54. There was more spread of scores among the females than in the males in the post-test.

Table 3: ANCOVA Summary on Main Effects of the Independent Variables on Achievement

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	17581.421[a]	4	4395.355	77.920	.000	
Intercept	53782.508	1	53782.508	953.449	.000	
PreA	99.350	1	99.350	1.761	.187	
Method	16821.669	1	16821.669	298.212	.000	S
Gender	79.078	1	79.078	1.402	.239	NS
Method * Gender	2.461	1	2.461	.044	.835	NS
Error	6543.372	116	56.408			
Total	389600.000	121				
Corrected Total	24124.793	120				

Table 3 shows that at 0.05 level of significance, 1df numerator and 120df denominator, the calculated F is 298.212 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis was rejected. Thus, there is significant difference between the mean achievement scores of students taught computer studies using PVP and those taught using conventional method.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 120df denominator, the calculated F is 1.402 with P-value of 0.239 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 120df denominator, the calculated F is 0.44 with P-value of 0.835 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on the achievement of students in computer studies.

Discussion

The study revealed that the effect of projected video package (PVP) is significant when compared with the conventional teaching method. Those exposed to PVP had high gained mean score than those in the conventional group. This observed difference in the mean achievement of students could be attributed to the fact that the use of projected videos in the instructional process appeals to the many senses of the students. It also creates a lot of experience for the students enabling them to properly understand the concepts taught, thus, improving achievement. This is in line with the findings of Omiola, Enuwa, Awoyemi and Bada (2012), Isiaka, Moses and Olumorin (2013), Okoro and Ekpo (2016) which revealed that ICT-enabled learning improved students' achievement in various subject areas.

According to Omiola et al. (2012), the ability of PVP to improve students' achievement is because it offers students the opportunity of learning with many senses and thereby engages the students actively. PVP also reduce the abstraction in understanding the concepts. This is because the use of videos makes it easy for the students to see what they need to know rather than imagine it. With the projections, the teacher easily administered class exercise which gave the students opportunity to evaluate their learning and enhance relearning. The use of projection therefore became useful not only for the teacher but also for the students by making them take responsibility for their own learning with each student showing keen attention in what was projected and making every possible effort to learn from it.

The use of PVP also helped the students to comprehend what was taught by simply viewing with concentration. As explained by Marshall (2002), viewing is an active process which can be an on-going and highly interconnected process of monitoring and comprehending and a complex, cognitive activity that develops and matures with the child's development to promote learning. For Mayer (2011), viewing may appear to be passive, but it involves the high cognitive activity necessary for active learning, Well-designed video instructional messages

can promote active cognitive processing in students even when they seem to be behaviourally inactive.

The Use of PVP communicated to the students not only cognitively but also in the affective domain. The videos therefore, had a strong positive effect on both motivation and affective learning. To the students, what was being taught sounded so realistic? They could see it being done and could follow similar steps to do same. The video projections also made it easy to practice what was being shown like understating the features of presentation packages and being able to use them.

The finding of the study is line with that of Okoro and Ekpo (2016) who reported that students taught using PVP performed better than those taught using conventional method of instruction. However, the finding contradicts that of Awoyemi and Bada (2012) who reported that developed video instructional package was not significantly better than those taught without video instruction. The finding of the study further revealed that there was no significant difference between the achievement of male and female students taught using PVP instruction. This is because the use of PVP uniformly enhanced the achievement of male and female students since it has the inherent capacity to arouse the interest of the students and the motivation to learn, they all got involved actively irrespective of their gender.

The finding of the study is in line with that of Alabi (2014) and that there was no significant difference in the achievement of male and female students when videotaped instruction is used. The findings also supported that of Awoyemi and Bada (2012) that gender was not a factor in the achievement of students taught using videotaped instruction. The finding of the study contradicts that of Aniweze (2014) who reported that female students retained learning materials more than the males when videotaped instruction was used. The findings of the study also contradicted that of Agommuoh (2013) who reported that male students scored higher than female students when video instruction was used.

The study concludes therefore, that the adoption of PVP could improve the achievement and retention of computer studies students. Based on the findings of the study, it is recommended that:

1. Computer studies teachers should use projected video package instruction in the teaching and learning process to ensure better achievement among students.
2. Workshop should be organized by education stakeholders to train computer studies teachers on the skills needed for the competent use of PVP in instructional delivery.
3. Government should supply secondary schools with standby projectors and power systems to enable computer studies teachers use PVP instructional approach at will.

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Effect of Think-Pair-Share Instructional Strategy on Secondary School Students' Academic Achievement in Biology in Anambra East Local Government Area, Anambra State

[1] Uzoma, J. I. & [2] Okoli, J. N.
[1,2] Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
[1] julieuzoma@gmail.com [2] jn.okoli@unizik.edu.ng

Abstract

This study investigated the effect of think–pair-share instructional strategy on secondary school students' academic achievement in Biology. Two research questions and three hypotheses guided the study. The study adopted a quasi-experimental design. The sample was made up of 73 (38 males and 35 females) senior secondary class two (SS2) Biology students, from two public co-educational schools in Anambra East Local Government Area of Anambra State. The experimental group had 40 students (23 males and 17 females) while the control group had 33 students (15 males and 18 females). Purposive sampling technique was used to select the sample. Biology Achievement Test (BAT) was used for data collection. The test was administered once and the reliability index of 0.95 was established on BAT using Kuder Richardson Formula 20. The experimental group was taught using think-pair-share instructional strategy while the control group was taught using conventional method. Mean and standard deviation were used to answer the research questions while Analysis of Covariance was used to test the null hypotheses at 0.05 level of significance. The result showed that a significant difference exists in the mean academic achievement scores of students in Biology in favour of the experimental group. There was no significant difference in the mean academic achievement scores of male and female students taught Biology using think–pair-share instructional strategy. Based on the findings, the researcher recommended among others that biology teachers should adopt the use of think-pair- share instructional strategy in order to improve both male and female students' academic achievement in biology.

Keywords: Think-pair- share, academic achievement, biology students

Introduction

Biology is one of the science subjects that boost the development of scientific and technological attitudes in students. It is a branch of science that studies life (Ramalingam, 2011). The study of Biology helps the learners grow up into informed citizen, gain more knowledge about their body and the environment in which they live in. A sound knowledge of Biology is needed in our everyday life; including the food we eat, water we drink and is required in many fields such as medicine, pharmacy, nursing and Agriculture. Industries like tanning, textile, brewing and other food manufacturing industries all need the knowledge of

Biology. Knowledge acquired through Biology can help in problem solving and decision making in public policy issues. Considering the importance of Biology to humanity, students are expected to manifest high level of achievement in this school subject both at internal and external examinations

Academic Achievement represents performance outcomes that indicate the extent to which a person has accomplished specified goals that were the focus of activities in instructional environment, specifically in school, college and universities (Oxford, 2014). It is an important parameter in measuring success in students. When students are successful in biology examination, they will have feeling of pride that they made success through their own effort and skills. Such little success can even give them sense of achievement and accomplishment (Obialor, 2016). However, students' performance in this subject (biology) at external examination had remained persistently poor (Obialor, 2018). For instance, In Sakiyo (2015) work on the assessment of trend of secondary school students' academic performance in Sciences, Mathematics and English, the researcher discovered that Biology had the highest failure rate of 28.66% compared with mathematics 24.39%, chemistry 22.52%, English 21.89% and physics 13.08%. The WAEC result summary in Biology 2012/2013, 2013/2014, 2014/2015, 2015/2016, 2016/2017 and 2017/2018 in Anambra East local government area in Anambra State, showed unsatisfactory students' academic achievement in Biology.

The poor performance of students in biology has been attributed mainly to poor teaching method adopted by most biology teachers (Nwagbo & Obiekwe, 2009; Okoli, 2006). Thus, Okoli (2006) opined that most science teachers still prefer lecture method of teaching, that is, a teaching method in which the teacher presents a spoken discourse on a particular subject and avoid the use of activity-oriented teaching methods which are student-centred such as inquiring methods, discovering methods and investigative laboratory approach. Obialor (2016) maintained that such teacher-centred approach in which there is a steady flow of

information going from the teacher to the students does not enhance achievement in science subjects particularly biology. Hence in this study, the researcher sought to find out if think-pair-share instructional strategy would improve students' academic achievement in biology.

Think-Pair-Share Instructional Strategy is a type of cooperative learning strategy in which students work on a problem posed by the instructor, first individually and independently, then in pairs and finally as a group – wide discussion (Kothiyal, Majumdar, Murthy & Lyer, 2013). According to the researchers, it is an activity- based learning strategy in which students are engaged in a specific activity, often collaborative in which they express their thinking through writing, speaking or other actions that go beyond listening and copying of notes. Furthermore, Ifamuyiwa and Onakoya (2013) noted that think-pair-share instructional strategy has three distinct stages from where it derives its name the "think", "pair", "share". During the "think stage" each learner is allowed to think individually and independently about the given task, problem or question posed by the teacher, each one forming ideas of their own on what they know or have learnt about the given topic. Those thoughts or ideas can be written down in their jotters. During the "pair stage" learners are allowed some time to pair with another student to share their mental or written ideas, reflect on their ideas together and to come up with their most convincing ideas. During the "share stage" the teacher calls out pairs to present their thoughts, ideas or questions within a given time. The teacher can expand the "share" into a whole-class discussion. The teacher can also expand some ideas and correct misconceptions which may arise.

Think-Pair-Share Instructional Strategy may portray the following advantages: the strategy is easy to maintain, it increases students' self-esteem and participation, encourages collaboration, helps to deepen understanding of concepts, helps to dispel misunderstanding promptly, promotes and supports higher level of thinking, promotes retention, improves communication and listening skills, give teachers opportunity to assess their students individual

abilities. Think-Pair-Share Instructional Strategy is not left without disadvantages. These include: it may be time consuming if not properly planned, hard to assist all learners if the group is many, low ability ones may not be engaged in the think stage. Chianson, O'kwu and Kurumeh (2015) reported that think-pair-share instructional strategy improved students' achievement in mathematics (fraction).In a similar vein, this research sets out to investigate the effect of think-pair-share instructional strategy on secondary school student` academic achievement in biology.

Apart from teaching method used by teachers in teaching the students; the influence of gender on students' achievement in science in general and biology in particular has been a global concern to science education and researchers. However, there is no agreement among researchers on the studies on gender effect. For instance, Nwagbo and Chukelu (2011) reported that there is no significant difference in the academic achievement of male and female students in Biology while Okoli and Egbunonu (2012) found that male students achieved significantly higher than their female counter parts in Biology. Dania (2014) opined that a good teaching method is capable of neutralizing gender difference in students' academic achievement. As a result of the above revelations, there is need for further investigation to ascertain how male and female students will perform in Biology if taught using think-pair-share instructional strategy.

Purpose of the Study

The purpose of this study was to ascertain the effect of think-pair- share instructional strategy on secondary school students' academic achievement in Biology. Specifically, the study aimed at ascertaining the:

1. Difference between the mean achievement scores of secondary school students taught biology with think-pair- share instructional strategy and those taught with conventional teaching method using their pre-test and post-test mean scores.

2. Difference between the mean achievement scores of male and female secondary school students taught biology with think-pair-share instructional strategy using their pre-test and post-test mean scores.
3. Interaction effects of teaching methods and gender on the mean achievement scores in biology.

Research Questions

The following research questions guided the study:

1. What is the difference between the mean achievement scores of secondary school students taught biology with think-pair-share instructional strategy and those taught with conventional teaching method?
2. What is the difference between the mean achievement scores of male and female secondary school students taught biology with think-pair-share instructional strategy?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean achievement scores of secondary school students taught biology with think-pair share instructional strategy and those taught with conventional teaching method.
2. There is no significant difference between the mean achievement scores of male and female secondary school students taught biology with think-pair- share instructional strategy.
3. There is no interaction effect of teaching methods and gender on the mean achievement scores in biology.

Method

The study adopted a quasi-experimental design, specifically non-equivalent control group design. The study was carried out in Anambra East LGA of Anambra State. The choice for the area is based on the fact that the students' academic achievement in Biology in the area has been persistently poor. The population for this study comprised 247 SS2 biology students (119 males and 128 female) in the government owned co-educational secondary schools in Anambra East LGA. The choice of co-educational schools was to take care of the gender variable in the study. The sample was made up of 73 (38 males and 35 females) SS 2 biology students drawn from two schools using purposive sampling technique. The instrument used for data collection was Biology Achievement Test (BAT) constructed by the researcher. The instrument was validated by two experts in science education and measurement and evaluation from Nnamdi Azikiwe University, Awka and one experienced secondary school biology teacher. The reliability of the instrument was ascertained using Kudder-Richardson Formula 20and coefficient of 0.95 was obtained.

The regular biology teachers of the sampled schools were used as research assistants. The pre-test was administered to both the control and experimental groups before the treatment. The same instruments were administered to both the experimental and control group as pre-test. The treatment group was taught using think-pair-share while the control was taught using conventional teaching method. Immediately after treatment, the same instrument used as pre-test was given to both the experimental and control groups as post-test but were reshuffled and printed in a colour paper. Mean and standard deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance.

Result

Research question 1: What is the difference in the mean achievement scores of secondary school students taught biology with Think-Pair-Share Instructional Strategy (TPSIS) and those taught with conventional teaching method?

Table 1: Pre-test and Post-test Mean Achievement Scores of Students taught Biology using TPSIS and those taught using Conventional Method

Source of variation	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gain in Mean	Difference in Mean
TPSIS	40	25.25	4.75	83.63	4.55	58.38	33.47
Conventional	33	24.18	4.02	49.09	4.23	24.91	

Table 1 reveals students taught with TPSIS had post-test mean score of 83.63 which is higher than 49.09 of those taught with conventional method. This means that those taught with TPSIS achieved more than those taught with conventional method in biology.

Research question 2: What is the different in the mean achievement scores of male and female secondary school students taught biology with Think-Pair-Share Instructional Strategy?

Table 2: Pre-test and Post-test Mean Achievement Scores of Male and Female Students taught Biology using TPSIS

Gender	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gained Mean	Difference in Mean
Male	23	25.65	3.47	81.61	4.62	55.96	2.98
Female	17	24.71	4.13	83.65	4.57	58.94	

Table 2 shows that with higher gain mean achievement score of 58.94, TPSIS is more effective in enhancing the achievement of female students in biology.

Hypothesis 1: There is no significant difference between the mean achievement scores of students taught Biology with think-pairs-share instructional strategy and those taught with conventional teaching method**.**

Table 3: ANCOVA on Mean Achievement score of Students taught Biology with TPSIS and those taught using Conventional Method

Source of variation	**SS**	**Df**	**MS**	**F**	**Sig.**	**Decision**

Corrected Model	20336.528[a]	4	5084.132	421.798	.000	
Intercept	5684.636	1	5684.636	471.618	.000	
Pre-test	2.224	1	2.224	.184	.669	
Gender	.133	1	.133	.011	.917	
Method	18204.767	1	18204.767	1510.333	.000	S
Method * Gender	3.372E-005	1	3.372E-005	.000	.999	NS
Error	819.637	68	12.053			
Total	353425.000	73				
Corrected Total	21156.164	72				

Table 3 shows that at 0.05 level of significance, the calculated F is 1510.333 with P value of .000 which is less than 0.05. Therefore, the null hypothesis was rejected. Thus, mean achievement score of students taught biology with think-pair-share instructional strategy is significantly different from those taught with conventional method in favour of the think-pair-share instructional strategy.

Hypothesis 2: There is no significant different between the mean achievement scores of male and female students taught Biology with think-pair-share instructional strategy.

Table 4: ANCOVA on Mean Achievement Scores of Male and Female Students taught Biology with TPSIS

Source of variation	**SS**	**Df**	**MS**	**F**	**P-value**	**Decision**
Corrected Model	.016[a]	2	.008	.001	.999	
Intercept	5684.104	1	5684.104	843.409	.000	
Pre-test	.001	1	.001	.000	.988	
Gender	.013	1	.013	.002	.965	NS
Error	249.359	37	6.739			
Total	273325.000	40				
Corrected Total	249.375	39				

Table 4 shows that at 0.05 level of significance, the calculated F is .002 with P value of .965 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant difference in the mean achievement scores of male and female students taught biology with think-pair-share instructional strategy using their post-test mean achievement scores.

Hypothesis 3: There is no interaction effect of teaching methods and gender on the mean achievement scores in biology.

Table 3 also shows that at 0.05 level of significance, the calculated F is .000 with P value of .999 which is greater than 0.05. Therefore, the null hypothesis was not rejected. Thus, there is no significant interaction effect of teaching methods and gender on students' achievement in biology.

Discussion

The findings of the study revealed that the mean achievement scores of students taught Biology with TPSIS is significantly different from that of those taught using conventional teaching method in favour of the experimental group. The observed significant difference in favour of those with TPSIS is attributed to the interaction with learning materials and among students. Instruction with think-pair-share allowed the students more time with the material they are learning. When they understand the concept, they interact among their peer either share what they have learnt or to ask questions and clarifications on what they did not understand. This sharing of ideas is one of the major factors that contributed to the students' improved achievement. The finding of the study is in support to the findings of Ifamuyiwa and Onakoya (2013) that think-pair-share instructional strategy increased students' achievement in Mathematics more than lecture method. The finding of the study is also in line with that of Bamiro (2015) who reported that students taught with think-pair-share instructional strategy had the highest post-test mean achievement score.

In the case of gender, the finding of the study revealed that male and female students did not differ significantly in achievement when taught with think-pair-share instructional strategy. This shows that students taught using think-pair-share approach were all carried along. Because of the interaction among students, all students were uniformly affected resulting in a fairly uniform achievement among students. The finding of the study is in contrast to those

of Aniodoh and Egbo (2013), and Uwaleke (2013) who discovered that female students achieved higher than male students in science. The finding of the study is in contrast to those of Okeke (2009), Okoli and Egbunou (2012) in their studies when they found out that male students achieved significantly higher than their female counter parts in science generally and Biology respectively. The findings of the study however are in line with the findings of Aniaku (2013); and Orjika (2012) found out that there was no significant difference in the achievement of male and female students in biology taught using TPSIS.

The study showed no significant interaction effect of teaching methods and gender on the achievement of students in biology. The findings of the study is in line with Ifamuyiwa and Onakoya (2013) that there was no significant difference in the achievement scores of male and female students taught Mathematics using Think-Pair-Share.

Conclusion

The study therefore, concludes that think-pair-share instructional strategy is effective in enhancing the achievement of students in biology irrespective of their gender.

Recommendations

Based on the findings of the study, it is recommended that:

1. Biology teachers should adopt the use of think-pair-share instructional strategy in order to improve students' achievement in learning biology.
2. In using think-pair-share instructional strategy, teachers should make sure to monitor group activities to make sure that students do not deviate from the objectives of instruction.

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Effects of Constructivist-Based Instructional Model on Secondary School Students' Academic Achievement in Mathematics in Enugu Education Zone

Nwigwe, E. C.
esthernwigwe20@gmail.com
&
Osuafor, A. M.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
am.osuafor@unizik.edu.ng

Abstract

The study explored the effects of constructivist-based instructional model (5E instructional model) on secondary school students' academic achievement and critical thinking skills in mathematics in Enugu Education Zone. Two research questions guided the study and three null hypotheses were tested at 0.05 level of significance. The study adopted a quasi-experimental design involving 2 x 2 factorial arrangements. 96 SS2 mathematics students in Enugu Education Zone of Enugu State were involved in the study. The Achievement Test in Probability (ATP) was used for data collection. The instrument was validated by two lecturers, one in the Department of Science Education and the other in the Department of Educational Foundations, Nnamdi Azikiwe University, Awka and one experienced secondary school teacher. The reliability of the instrument which was established using Kudder-Richardson 20 was 0.84. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used for testing the null hypotheses. The findings of the study indicated that constructivist-based instructional model had significant effects on students' academic achievement. Also the influence of gender on the students' achievement in probability was not significant. The study recommended that teacher education programmes should include constructivist-based instructional model in mathematics teaching method. This will ensure that mathematics teachers are adequately trained on how to use constructivist-based instructional model in teaching and learning.

Keywords: constructivist-based, probability, achievement, mathematics, Ancova

Introduction

Sustained development and advancement of any nation depend to a large extent on the rate of her scientific and technological development. Ali and Hamze (2013) stated that a well developed and implemented science and technology education programme of a country would not only produce knowledgeable and skilled manpower for the workforce but also usher in sustainable socio-economic growth and political stability in that country. Hence, science education is a veritable tool for national development.

Mathematics is one of the core science subjects taught at the senior secondary schools in Nigeria. Mathematics can be described as the subject of figures or science of size and number. Mathematics can also be described as the bedrock of all other science subjects and technology-based courses (Esiana, 2012). Mathematics is the only subject all pupils in the world learn for often more than nine years. Why is this so? Because mathematics is central to our understanding of the world in which we live to the control of our environment, and to the organization of our society. Owing to the usefulness of mathematics, it is regarded as a necessary requirement in basic education.

Despite the importance placed on Mathematics, it is very disappointing to note that students' performance in the subject at the secondary school level of education over the years has remained consistently poor. Also statistics show that mass failure in mathematics examination is real and then trend of students' performance has been on the decline (West African Examination Council Chief Examiner's reports of 2016 - 2018). Many variables had been identified by Chirume and Chikasha (2014) as responsible for the poor performance of students in mathematics. Such variables include governments, curriculum, examination bodies, teachers, students, home, and textbook. Apart from these variables, some specific variables have been identified by Chirume (2012) to include poor primary school background in mathematics, lack of incentives for the teachers, incompetent teachers in primary schools, students not interested in hard work, perception that mathematics is difficult, large class syndrome, psychological fear of the subject, poor method of teaching and lack of qualified mathematics teachers, which result in teaching of the subject by unqualified untrained and inexperienced teachers.

Researchers have in recent time focused their research efforts on strategies that will enhance the teaching and learning of mathematics. Nowadays, researchers have shifted their emphasis from traditional instruction that is teacher-centred, where teachers communicate their

ideas to learners by direct verbal discourse, discuss and demonstrate ideas. Traditional instruction which have advantages such as saving time that enable teachers to cover their scheme of work; permits adaptability, versatility and flexibility. But this method has not given sufficient opportunities to students to construct their own learning, thereby encourage rote learning of facts, as it involves transmission of knowledge by the teacher to passive students. In effect, students are seen as empty vessels into which knowledge is poured.

Apart from traditional instruction, there are other methods that will enhance effective teaching and learning. Example is constructivism method. Constructivism is an epistemology, a theory of knowledge with roots in Psychology and Cybernetics used to explain how we know what we know. The focus on this perspective is on making teaching and learning more relevant, purposeful and useful to the lives of the learner through application of concepts and real life examples across diverse work place setting (Nworgu, Brittan, Humtly, Jacob & Weinberg in Amaefuna, 2013). Constructivism as a Philosophy believes that people in different works of life may interpret the same phenomenon in very different ways (Nwamaradi, 2007). Therefore, constructivism uses various views in negotiating knowledge and truth and students should be seen as colleagues in this negotiation.

According to Eggen and Donald (2011), instructional models based on constructivism called 5E instructional model, is a five-phase instructional model comprising: engagement, exploration, explanation, elaboration and evaluation. Engagement simply means that the lesson mentally engages students with an activity or question. It captures their interest, provides an opportunity for them to express what they know about the concept or skill being developed and helps them to make connections between what they know and the new ideas. The second phase is exploration**,** which involves students carrying out activities in which they can explore the concept or skills. This phase allows students to acquire a common set of experiences that they can use to help each other make sense of the new concept or skill. The third phase is

explanation, this phase of the 5E's helps students explain the concepts they have been exploring. They have opportunities to verbalize their conceptual understanding or to demonstrate new skills or behaviours. This phase also provides opportunities for teachers to introduce formal terms, definitions and explanations for concepts, processes, skills or behaviours. The fourth phase is elaboration, which provides opportunities for students to apply what they have learned to new situations and so develop a deeper understanding of the concept or greater use of the skill. It is important for students to discuss and compare their ideas with each other during this phase. Finally, the evaluation phase, which is the final phase that provides an opportunity for students to review and reflect on their own learning and new understandings and skills. It is also where students provide evidence for changes to their understandings, beliefs and skills.

The lesson activities are provided as opportunities for students to discover information for themselves and learn to mentor their family and peers about readiness, responding, resilience and recovery. Teachers can adapt the teaching activities to suit the level of their own classes. This 5E instructional model tends to reflect on constructivist principle adopted from Trowbridge, Bybee and Powell (1990). Constructivist-based model is a generalized programmatic approach derived from Piaget's theory, Vygosky's theory, Dewey's and Bruner's theory on mental functioning. Literature on constructivist-based model as written by Yelz (2015) and Abdel and Lafras (2014) have given credit to 5E instructional model. The phases of 5E instructional model allow the students to learn through their own experiences. Students must make sense of what they are taught and asked to learn. Due to role dominance of teachers in traditional instruction, the students do not engage in critical thinking and this leads to rote learning with little transfer of knowledge. Therefore, cognitive demands of scientific task as well as a reflective thought are reduced to a minimum in traditional instruction

(Mohammed & Alsheri, 2016). This study raises a very important issue; would 5E constructivist-based instructional model enhance students' achievement?

Academic achievement is the extent to which a student has achieved short or long term education goals. Among the many criteria that indicate academic achievement, there are very general indicators such as procedural and declarative knowledge acquired in an educational system, more curricular-based criteria such as grades or performance on an educational achievement test, and cumulative indicators of degrees and certificates. Academic achievement of students in this study is measured based on students' knowledge acquisition in probability, that was evaluated from their scores obtained in achievement test in probability (ATP). Achievement of students as regard to gender was also evaluated.

On the issue of gender, some research works have shown contradictory evidence in students' academic achievement in science due to gender. Yusuf and Afolabi (2010) investigated the effect of computer assisted instruction on students' performance in biology. The study aimed at designing computer- assisted instruction of high-level plant anatomy to support the 5^{th} grade of elementary schools students' learning outcomes, they found out that there was no statistical significant difference in the achievement of male and female students in biology. Girls and boys were found to perform equally well if instructional content is fair and conducive (Erinoso, 2008). However, Iwendi (2009) discovered that male secondary school students performed better than female in science and mathematics. Also Okwo and Olumba (2007) reported that boys performed better than girls in physics essay test. Raimi and Adeoye (2012) in their study on gender differences among college students as determinant of performance in integrated science found out that there is significant difference between male and female students in terms of their science achievement. The finding shows that male performed better than their female counterparts in integrated science achievement scores. A chemistry approach that included visual representation of matter led to positive attitude and

better performance by girls (Adesoji, 2008). In line with the above findings, meaningful instructional strategy appeared to be a solution to gender differences in science achievement. It is therefore reasonable to determine gender related differences in mathematics using constructivist based-instructional model (5E Instructional Model).

Purpose of the Study

The purpose of this study was to determine the effect of 5E instructional model on mathematics achievement of secondary school students. Specifically, the study was designed to determine the:

1. Difference in mean achievement scores of students taught mathematics with 5E Instructional model and those taught with Conventional method.
2. Difference in mean achievement scores of male and female students taught mathematics with 5E Instructional model.
3. Interaction effect of gender and instructional models on students mean achievement scores in mathematic.

Research Questions

1. What is the difference in mean achievement scores of students taught mathematics with 5E instructional model and those taught with Conventional method?
2. What is the difference in mean achievement scores of male and female students taught mathematics with 5E instructional model?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught mathematics with 5E instructional model and those taught with conventional method.
2. There is no significant difference between the mean achievement scores of male and female students taught mathematics with 5E instructional model.

3. There is no interaction effect of instructional models and gender on students' achievement scores in mathematics.

Method

The design for this study is quasi-experimental design. The study was conducted in Enugu Education Zone of Enugu State. The population comprised the entire senior secondary year two (SS2) students, 2018/2019 academic session students in the 20 co-educational secondary schools in Enugu education zone of Enugu State (Post Primary Schools Management Board, Enugu zonal Office, Students' Enrolment 2018/2019 Session). The sample for the study consists of 96 senior secondary year two (SS2) students that were drawn from two schools out of the 20 co-educational secondary schools in Enugu Education Zone using a multi-stage sampling technique. Simple random sampling (lucky dip) was used to select two local government areas in the Zone. At this stage, Enugu East LGA and Enugu North LGA were selected. Purposive sampling was used to sample co-educational schools in the two LGA sampled, in order to make the research gender sensitive in an equal footing. Simple random sampling (lucky dip) was used to select two schools, one each from the two LGA. Simple random sampling (toss of the coin) was also used to choose one school as the experimental group and the other as the control group. In each of the two schools, one intact class was randomly used for the experiment. The experimental group was made up of 49 SS2 students while the control group was made up of 47 SS2 students, totally 96 students.

The instrument for data collection was Achievement Test in Probability (ATP). The achievement test in probability consists of 30 multiple choice objectives format test items of four options, selected from past examination questions of West African Examination Council (WAEC) and National Examination Council (NECO). In line with the senior secondary two (SSII) syllabus and scheme of work, the instrument covers the four major division of probability, namely experimental, theoretical, mutually exclusive and independent events. In

the instrument, each item of the multiple-choice questions comes with four options (A - D) which serve as possible answers to each question. The achievement test in probability (ATP) was validated by three experts, one in educational measurement and evaluation, one in science education (mathematics), both from Nnamdi Azikiwe University Awka and the other from secondary school. To estimate the reliability of the achievement test in probability (ATP) the instruments were administered on 30 SSII students in one of the secondary schools in Udi Education Zone of Enugu State outside the research area. Kudder Richardson 20 was used to determine the reliability of ATP and was found to be 0.84.

Before treatment commenced, mathematics class teachers of the sampled schools which had a minimum of bachelor's degree in science education (mathematics) were trained on how to carry out treatment on each group. The researcher trained the mathematics teachers (research assistants) individually by going through the lesson plan respectively and instructed the teachers to strictly follow it with the specified time allocation. The experimental group teacher was given detailed explanations on the 5E instructional model, the 5E instructional lesson plans, and on how to incorporate the 5E phases into the lessons and the general requirements of the research. The control group teacher was briefed on the general requirements of the research since the teacher was required to use the conventional instructional model to teach without incorporating 5E instructional procedures. By the end of the two weeks training, the researcher organized a micro teaching session for the participating teachers to ensure that they have mastered the instructional technique expected of them.

The researcher, with the aid of the two research assistants (class teachers), first of all subjected the two randomly selected intact groups to a pre-testing exercises with the ATP. Thereafter, the experimental and control groups were subjected to the treatment. The actual experiment was conducted by the two trained research assistants, that is, the class teachers. Experimental group was taught using 5E instructional model and the control group was taught

using conventional instructional model. The 5E instructional model lesson plans incorporates five phases based on 5E instructional procedures; Engagement, Exploration, Explanation, Elaboration and Evaluation. This instructional model addressed students' misconceptions. In order to verify the treatment, the researcher observed instructions in both groups randomly without the knowledge of the students. The treatment lasted for four weeks using the normal school timetable of 80 minutes for double period. At the end, the same achievement test was reshuffled and given to both the experimental and control groups as post-test during the continuous assessment period.

A situation whereby participants from the control and experimental groups intermingle frequently and transfer ideas will influence results of the study. Also for this reason, in sampling schools into the control and experimental groups, the distance between each school was considered and schools with far distance apart was chosen. The researcher minimized bias by making use of their normal mathematics teachers to teach each group. Also, students in the various groups were administered the same instruments (ATP and CTA) which were marked by the researcher with the same marking scheme. The research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using Analysis of Co-variance (ANCOVA). The adoption was to take care of error due to initial differences in ability among the research participants. The decision rule was to reject null hypothesis where p-value was less than 0.05 and not to reject the null hypothesis where the p-value was greater than 0.05.

Results

Research Questions 1: What is the difference in mean achievement scores of students taught mathematics with 5E instructional model and those taught with Conventional method?

Table 1: Pre-test and Post-test Mean Achievement Scores of Students in 5EIM group and CIM group

Source of Variation	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
5EIM	49	17.27	76.51	59.24	6.42	11.29
CIM	47	16.72	60.70	43.98	5.38	15.28

Table 1, shows that the experimental group (5EIM) had a pre-test mean score of 17.27 and a post-test mean score of 76.51 with a mean gain of 59.24, while the control group (CIM) had a pre-test mean score of 16.72 and a post-test mean score of 60.70 with a mean gain of 43.98. Standard deviations scores of 11.29 and 15.28 shows that post-test scores of both groups are widely spread around their mean scores, because both groups have a high standard deviation scores.

Research Questions 2: What is the difference in mean achievement scores of male and female students taught mathematics with 5E instructional model?

Table 2: Pre-test and Post-test Mean Scores of Male and Female Students taught Chemistry using ICCS

Gender	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
Male	22	16.14	74.50	58.36	5.76	13.51
Female	27	18.19	78.15	59.96	6.89	9.10

Table 2 shows that male students in the experimental group had pre-test mean score of 16.14, post-test mean score of 74.50 with a mean gain score of 58.36 while, the female students in the group had a pre-test mean score of 18.19, post-test mean score of 78.15 with a mean gain score of 59.96. Standard deviations scores shows that post-test scores of female students are more clustered around their mean score compared to that of their male counterpart.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught mathematics with 5E instructional model and those taught with conventional method.

Table 3: ANCOVA on Difference in the Achievement Scores of Students taught probability using 5EIM and CIM

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	8511.916	4	2127.979			

Intercept	29720.919	1	29720.919			
Pre-test	2351.779	1	2351.779			
Method	5532.933	1	5532.933	35.084	.000	S
Method*Gender	36.062	1	36.062	.229	.634	NS
Error	14351.043	91	157.704			
Total	22862.958	96				

Table 3 shows that at 0.05 level of significance, 1df numerator and 96 df denominator, the calculated F is 35.084 with P-value of .000 which is less than 0.05. Therefore, the null hypothesis was rejected. Thus, there is significant difference in the mean achievement scores of students taught mathematics with 5E instructional model and those taught with conventional method in favour of 5E instructional model.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught mathematics with 5E instructional model.

Table 4: ANCOVA on Significant Difference of ICCS on Male and Female Students' Achievement in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	1205.001	2	602.501			
Intercept	23412.437	1	23412.437			
Pre-test	1034.664	1	1043.664			
Gender	54.139	1	54.139	.506	.480	NS
Error	4917.244	46	106.897			
Total	292959.000	49				

Table 4 shows that at 0.05 level of significance, 1df numerator and 49 df denominator, the calculated F is 0.506 with P-value of 0.480 which is greater than 0.05. Therefore, the null hypothesis was rejected. Therefore, there is no significant difference between the mean achievement scores of male and female students taught mathematics with 5E instructional model.

Hypothesis 3: There is no interaction effect of instructional models and gender on students' achievement scores in mathematics.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 96 df denominator, the calculated F is 35.084 with P-value of 0.000 which is greater than 0.05.

Therefore, the null hypothesis was not rejected. Therefore, there is no interaction effect of instructional models and gender on students' achievement scores in mathematics.

Discussion, Conclusion and Recommendations

5E instructional model (5EIM) was a significant factor on students' achievement in probability since p-value of 0.001 obtained is less than 0.05. Thus, the experimental group achieved much better than the control group. This finding that showed the positive impact of 5EIM on students' achievement is in line with that of Hamdani (2013), Abo-ssfr (2014) and Mohammed (2016) who in their separate studies found that the adoption of 5EIM as an instructional frame work greatly improves students' academic achievement. This could be attributed to the fact that the use of 5EIM gives students the opportunity to participate actively in the class by interacting freely with the teacher, learning material and their peers, learn in groups and assess their performances themselves which helps them to improve in their self-esteem, enthusiasm and their willingness to take ownership and responsibility for their learning. This in turn led to a considerable improvement in their achievement.

Gender was not a significant factor on students' achievement in probability since p-value of 0.480 obtained was greater than 0.05. This result was attributed to the fact that students were exposed to different teaching procedures which impact their individual learning styles. This finding is in agreement with those of Abo-ssfr (2014) and Hamdani (2013) whose studies showed no significant difference between the achievement of male and female students in mathematics. Contrary to the findings was the report of Yelz (2015), whose study showed a significant gender difference on students' achievement in favour of female students.

There was no interaction effect of gender and instructional models on students' achievement in mathematics since the p-value of 0.634 obtained is greater than 0.05 level of significance on which the hypothesis tested. This implies that the effect of teaching methods on achievement was consistent across gender. The present finding is in agreement with Abo-

ssfr (2014) whose study showed no interaction effect of gender and instructional models on students' achievement.

The study had shown that 5E instructional model had significant effects on students' academic achievement and critical thinking skills. The 5E instructional model appeared to be outstandingly more effective than the conventional instructional model. Based on the findings of this study the following recommendations are put forward.

1. Teacher education programmes should include 5E instructional model in mathematics teaching method. This will ensure that mathematics teachers are adequately trained on how to use 5EIM in teaching and learning.
2. Ministries of education, both state and federal should organize workshops and seminars and sponsor teachers to attend in service courses on how to improve their teaching skills using 5E instructional model, which is found by this study to be effective in promoting students achievement and critical thinking skills in mathematics.

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Effect of Instructional Scaffolding on Achievement in Biology by Secondary School Students' with Different Cognitive Styles in Awka Education Zone

Ufommadu, O.
Antylove4christ@gmail.com
&
Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
jn.okoli@unizik.edu.ng

Abstract

The study investigated the effect of instructional scaffolding on achievement in biology by secondary school students with different cognitive styles in Awka Education Zone. Five research questions guided the study and six hypotheses were tested in the study at 0.05 level of significance. The study adopted quasi-experimental design specifically, the pre-test post-test control group non-equivalent control group design. The population of the study consisted of 3,065 senior secondary school two (SS2) students offering biology in Awka Education Zone. Multistage sampling procedure was used to select a sample size of 108 students involved in the study. The instruments used for data collection were Biology Achievement Test (BAT) and Group Embedded Figure Test (GEFT). The BAT was validated by experts in Department of Science Education and Education Foundation and one experienced biology teacher. BAT reliability was established using Kudder Richardson 20 which yielded reliability coefficient of 0.80. Students in the experimental group were taught using instructional scaffolding while those in the control group were taught using conventional method. Data relating to the research questions was analysed using mean and the hypotheses were analysed using Analysis of Covariance. The findings of the study showed that instructional scaffolding improved the achievement of field dependent and field independent students. The study also found out that the use of instructional scaffolding enhanced the achievement of field independent students more than those that of field dependent. Based on the findings, it was recommended among others that Science Teachers Association of Nigeria should organize seminars and workshops to train biology teachers on the use of instructional scaffolding.

Keywords: Scaffolding, biology, achievement, cognitive styles

Introduction

Biology is the science of life. Nick (2014) noted that the study of biology enables learners to understand our environment, giving them knowledge about the animals and plant in their surroundings. The study of Biology was designed to enable learners develop skills of problem solving and decision making and to understand the relationship among biology and

health, agriculture, industry and life in general. Despite the importance of Biology, students' academic achievement in this subject has remained persistently poor (Erinosho, 2013).

Academic achievement is the outcome of instruction. Academic achievement may sometimes be represented with scores or grades which indicated the level of students' learning. It is important to know that from May/June 2007 – 2017, Senior School Certificate Examination statistics by West African Examination Council (WAEC) revealed that the percentages of candidates who passed at credit level and above (grade 1-6) in Biology were low. In all the years, the percentage was never up to 50%. This poor achievement in biology has been attributed to many factors. Some of the notable factors are lack of adequate laboratory facilities, lack of instructional aids, poor teaching method used by biology teachers and students' style of learning (Erinosho, 2013). The attentions of teachers and researchers have overtime been directed to providing an effective solution to the problem of poor achievement in external examinations in Nigeria. Most research focus seems to be on instructional modes. The reason is not farfetched. It is simply because effective methods of teaching can arouse students' interest, sustain motivation and engage them actively in learning.

The use of conventional method of teaching is common among science teachers including biology teachers. Conventional method could be any method or mix of methods which the teacher uses during instruction. Conventional teaching method is often teacher-centred and results in less participation on the part of the students. The use of innovative teaching methods including instructional scaffolding, however, is thought to be helpful and needed to be examined to establish whether it could help to enhance the students' achievement in biology.

Instructional scaffolding, according to Sawyer (2006) is the provision of support to promote learning when concepts and skills are being first introduced to students. According to Omiko (2015), scaffolding represents the helpful interaction between a teacher and learners

that enable the learners learn something beyond their independent efforts. It is a communication process where presentation and demonstration by the teacher is contextualized for the learner. Scaffolding requires time for adequate planning; else, students may still not be able to do the required tasks independently. However, when effectively planned, the interaction ensuing between teacher and student in the process could just provide enough support to enable the students accomplish the task. Not all individuals/students accomplish the same task at the same rate and at the same level of success. This differential level in accomplishment may be attributable to the students' cognitive styles.

Cognitive style according to Danna, Aigul, Marat, Aliya, Ainur, and Bibigul (2015) is the individual differences in the process of obtaining and processing information. Cognitive styles have been historically referred to as a psychological dimension representing consistencies in an individual's manner of cognitive and information processing (Kozhevnikov, 2007). Cognitive style also highlights the types of people depending on the characteristic of their cognitive orientation (Danna et al., 2015). Thus, cognitive style defines a method for processing information by a student and how the student uses different strategies for performing tasks. The student can either process information by associating it with the visible elements of a visible field and are termed Field Dependent learners (FD). They can otherwise process the information in isolation without any connections of the concepts to visible elements of their environment and are referred to as field Independent learners (FI). Since students manifest difference in their academic needs based on their cognitive style, there is need to examine how different instructional modes affect their achievement and which mode best improve their achievement.

The instructional mode of scaffolding deals with providing students with base knowledge about activities or tasks (Scaffolds) that they cannot do alone but are provided with more knowledge as the scaffolds are withdrawn. The use of scaffolding draws on the students'

cognition and thus, their cognitive style. The scaffolds which could be models, cues, think-aloud modelling, prompts, partial solutions, hints, and direct instruction is thought to be processed differently by FD and FI learners. Field independence (FI) in contrast to the field dependence (FD) is manifested in the analyticity of cognitive images: the propensity to detail and differentiate their educational experience, while adhering to the relevant elements of the perceived material.

Purpose of the Study

The purpose of this study was to investigate the effect of instructional scaffolding on achievement in biology by secondary school students with different cognitive styles. Specifically, the study sought to find out the:

1. The mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method.
2. The mean achievement scores of field dependent and field independent learners students in biology.
3. Interaction effect of instructional methods and cognitive style on students' achievement in biology.

Research Questions

1. What are the mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method?
2. What are the mean achievement scores of field dependent and field independent learners students in biology?

Hypotheses

The hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method.
2. There is no difference between the mean achievement scores of field dependent and field independent learners in biology.
3. There is no significant interaction effect of instructional methods and cognitive style on the achievement of students in biology.

Method

The design of the study is quasi-experimental. Specifically the non-equivalent pre-test post-test control group design was used. The area of study is Awka Education Zone of Anambra State. Awka Education Zone is made up of thirty-one (31) secondary schools. The population of the study was 3,065 (1240 males and 1825 females) senior secondary school two (SS II) biology students in the zone. The sample for the study comprised 108 students composed using multistage sampling procedure. Simple random sampling was used to select one local government in Awka Education Zone. Two co-educational schools were chosen purposively to ensure that the schools are situated miles apart to avoid subject contamination of class interaction. The two purposively chosen schools were then categorized into experimental and control group using the flip of a coin. In each school, simple random sampling was used to select one intact class.

The instruments for the study are Biology Achievement Test (BAT) and Group Embedded Figures Test (GEFT). The BAT was composed of 20 questions taken from Senior School Certificate Examination (SSCE) past questions relating to the concepts of skin and regulation of internal environment. A table of specification was used to determine the content

area to be measured in the pool of 20 multiple choice objective test items which were used as BAT. The instrument was used as pre-test before the treatment and as post-test after the treatment.

The GEFT was adopted from Witkin, et al. (1971) who developed the instrument to measure individuals' levels of field independency by tracing simple forms in the larger complex figures. The test instrument consists of 25 items for scoring. The total score is the number of figures that are correctly traced and the possible maximum score is 100. Generally, the GEFT manual (Witkin, Oltman, Raskin, & Krap, 1971) provides guidelines to identify different types of cognitive styles (Field Independent, FI, Field Neutral, Field Dependent, FD) by displaying the norms. Only the FI and FD were used in this study. According to the norm, students who scored above 50% are field independent and those who scored below 40% are field dependent. Also, lesson plans were developed for the treatment and control groups. The plans were organized for four (4) weeks of study.

The initial draft of the instruments, the purpose of the study, the research questions and hypotheses were validated by lecturers in Departments of Science Education and Educational Foundation of Nnamdi Azikiwe University, Awka, and one experienced biology teacher in Awka. The corrections of the validators were effected in the final copies of the instruments. The reliability of the BAT and GEFT were established using the Kudder-Richardson formula (Kr-20) which yielded coefficient of internal consistency of 0.80 for BAT and 0.78 for GEFT respectively.

The experiment was conducted in two phases namely: Phase A and Phase B. Phase A was for the training of the research assistants who are the regular biology teachers in the schools that were used in the study. Phase B was on the teaching of the students. The experiment commenced by administering the BAT as pre-test and the GEFT to determine the students' cognitive styles. Generally, in all the lessons, the students were provided with cues, charts,

explanations and question to guide them on the learning the concepts. The cues, charts, explanations, questions and task prompts were gradually removed so that the students carry on with the tasks on their own. The students for each class were introduced to a new concept for the week. They are immediately presented with probing questions to gain their attention. After the questions, charts on the concepts with brief explanation were given to the students. After the explanations, the students were given time to carry on with the study of the concepts and be asked to put up a note on the concepts studied. After, each lesson, students were engaged in a class discussion to ascertain the level of knowledge gained on the concept studied before proceeding to the next lesson. The teacher made up for every confusing issue which the students found hard to understand.

The control group was presented with the same concepts as the experimental group but without scaffolding but with conventional method. After the treatment, the students were given the BAT as post-test. To control for extraneous variables: the researcher used the regular classroom biology teachers to overcome hawthorne effect and eliminated experimenter bias by preparing the lesson notes and ensuring the teachers mastered the plan.

Data relating to the research questions were analysed using mean. Analysis of covariance (ANCOVA) was used to test the hypotheses. The reason for adopting the ANCOVA procedure was to help eliminate any initial differences in the entry abilities of the participants that extraneous-variable control measures could not properly address. The decision rule was to reject null hypothesis if p-value is less than 0.05, otherwise do not reject null hypothesis

Results

Research Questions 1: What are the mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method?

Table 1: Pre-test and Post-test Mean achievement Scores of Biology Students taught using Instructional Scaffolding (IS) and those taught using Conventional Method (CM)

Source of Variation	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gain in Mean
IS	55	20.55	7.31	50.73	5.22	30.18
CM	53	19.62	6.02	34.81	6.93	15.19

Table 1 reveals that the students taught biology using instructional scaffolding (IS) had pre-test mean score of 20.55 and post-test mean score of 50.73 with gained mean 30.18 in biology, while those in the control group taught with conventional method had pre-test mean score of 19.62 and post-test mean score of 34.81 with gained mean 15.91.

Research Questions 2: What are the mean achievement scores of field dependent and field independent learners students in biology?

Table 2: Pre-test and Post-test Mean achievement Scores of Biology Field Dependent and Independent Students

Method	Cognitive Style	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gain in Mean
IS	FD	37	20.95	7.57	44.32	5.73	23.37
	FI	18	19.72	7.34	63.89	6.08	44.17
Conventional	FD	33	20.61	7.26	34.55	6.77	13.94
	FI	20	18.00	6.16	35.25	7.34	17.25

Table 2 reveals that the field dependent students taught biology using instructional scaffolding (IS) had gain in mean scores of 23.37 while the field independent students had gain in mean scores of 44.17, while the field dependent students in the control group taught with conventional method had gain in mean score of 13.94 while the field independent students had gain in mean scores of 17.25.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method.

Table 3: ANCOVA on Main Effects and Interaction of Instructional methods and Cognitive Styles on Students' Achievement in Biology

Source of variation	SS	Df	MS	F	P-value	P ≤ 0.05
Corrected Model	11843.337[a]	4	2960.834	60.235	.000	
Intercept	18232.427	1	18232.427	370.921	.000	
Pre-test	364.904	1	364.904	7.424	.008	
Method	8763.651	1	8763.651	178.288	.000	S
Cognitive Style	2732.539	1	2732.539	55.591	.000	S
Method * Cognitive Style	2095.686	1	2095.686	42.635	.000	S
Error	5062.913	103	49.154			
Total	215825.000	108				
Corrected Total	16906.250	107				

Table 3 also shows that at 0.05 level of significance, 1df numerator and 107 df denominator, the calculated F is 178.288 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, there is significant difference in the mean achievement scores of students taught biology using instructional scaffolding and those taught using conventional method.

Hypothesis 2: There is no significant difference between the mean achievement scores of field dependent and field independent learners in biology.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 107 df denominator, the calculated F is 55.591 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, there is significant difference between the mean achievement scores of field dependent and field independent learners in biology.

Hypothesis 3: There is no interaction effect of instructional methods and cognitive style on the achievement of students in biology.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 107 df denominator, the calculated F is 42.635 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis was rejected. Thus, there is significant interaction effect of instructional methods and cognitive style on the achievement of students in biology. The nature of interaction is shown in the interaction plot in figure 2.

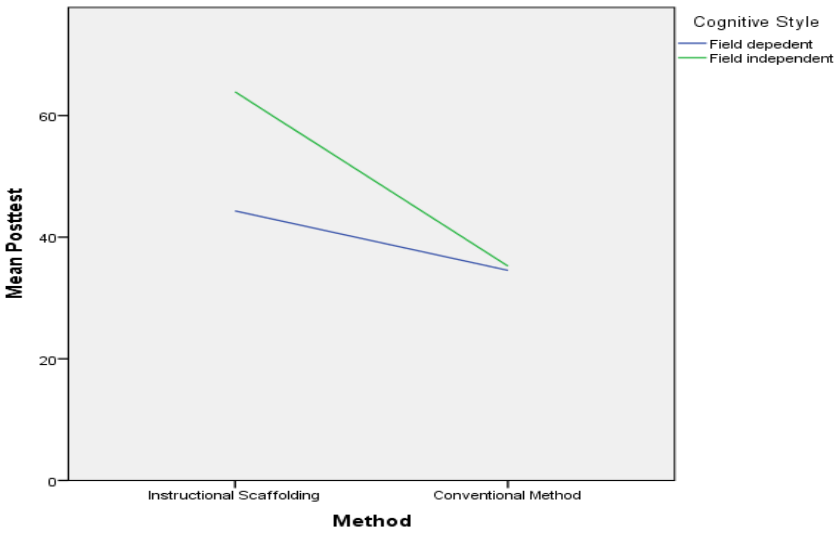

Figure 2: Interaction Plot of Teaching Methods and Cognitive Style on Students' achievement in Biology

The plot of the interaction effect between teaching methods and cognitive style is significant and ordinal. This shows that the teaching method is felt in one category of variable, that is, the teaching method is more sensitive to field independence.

Discussion

The study revealed that instructional scaffolding significantly enhanced the achievement of students in biology. The significant effect of instructional scaffolding can be explained from the fact that students at some point in the instructional process take responsibility for their own learning. The responsibility on the part of the students ensures their active participation during the lesson process. Since their students are to accomplish the tasks and objectives of the lesson alone, they tend to be engaged in a serious cognitive process that helps them to properly conceptualize what is learnt.

The finding of the study also revealed that instructional scaffolding effective enhanced the achievement of field dependent and independent biology students. However, instructional scaffolding was more effective in enhancing the achievement of field independent students in biology. The observed difference in the achievement of field dependent and field independent

students in biology could be due to the realistic distinction in the forms of understanding and cognitive processes of learners. The deference in the way of thinking is notably because field dependent students often need the teachers' intervention all through the lesson, unlike the field independent students who can do without the teacher.

The field independent students because of their cognitive orientation are independent of the teacher in their learning. The field dependent learners tend to perceive things in a relatively global fashion, being easily influenced by a prevailing field or context (sensitive to environment), group oriented, globally and socially oriented, extrinsically motivated and less structured and less autonomous in cognitive skills. This makes it easy to process information by associating it with relative things in the environment which could be independent of the teacher.

The findings of the study support that of Alake and Ogunseemi (2013) who conducted a study on the effects of scaffolding strategy on learners' academic achievement in integrated science. Alake and Ogunseemi (2013) revealed that that there was a significant difference in the achievement of the students in favour of those taught using scaffolding. The finding of the study also supported that of Omiko (2015) that there was a significant difference between the experimental and control groups in the study in favour of the scaffolding group. The finding of the study is in line with that of Jantan (2014) who noted that that cognitive style significantly influenced achievement and that students may differ in their cognitive style. The finding of the study however, contradict that of Ugwumba and Bitrus (2014) that there is no significant difference in the Physics achievement of students based on their cognitive style and that there were also no significant interaction effects of cognitive style and treatment method based on their mean achievement scores. The study concluded that instructional scaffolding is effective for improving senior secondary school students' achievement in biology and that instructional

scaffolding is sensitive to cognitive style. The following recommendations were therefore, made in the light of the findings of the study:

1. Biology teachers should adopt instructional scaffolding as one of the effective means to improve on the achievement of students in biology.
2. School administrators should encourage biology teachers to adopt often the use of instructional scaffolding during lesson delivery.

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Predictive Powers of Learning Style, Self-Regulated Learning Skill and Achievement Motivation on Secondary School Students' Achievement in Mathematics in Imo State

DURU, D. C.
Anambra Imo River Basin Development Authority, Owerri, Imo State, Nigeria
dcduru@gmail.com

&

OKEKE, S. O. C.

Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
soc.okeke@unizik.edu.ng

Abstract

The predictive powers of learning style, self-regulated learning skill and achievement motivation on secondary school students' achievement in mathematics in Imo state was investigated due to the persistent poor performance of students in the subject. It adopted a predictive correlational survey research design. The sample for the study comprised of 882 SS2 students randomly selected from fourteen public senior secondary schools in Owerri Education Zone of Imo State. The instruments used were Barsch Learning Style Inventory (BLSI), Self-regulated Learning Questionnaire (SRLQ) and Achievement Motivation Scale (AMS). The cumulative average scores of students' results were used as their academic achievement scores. Three experts validated the instrument. The reliability was established using Cronbach Alpha which were found to be 0.85, 0.89 and 0.81 respectively for BLSI, SRLQ and AMS. The data collected were analysed using correlation coefficient and multiple regression with the aid of (SPSS) version 20. The results of the study revealed that learning style, self-regulated learning skill and achievement motivation predicted 1.9%, 1.0% and 0.6% respectively to the variance observed in students' achievement scores in mathematics. The result also showed that the predictor variables jointly accounted for only about 2.3% of the variance observed in mathematics achievement scores of students which was significant. The study recommended that, there is need to help secondary school students overcome every problem associated with learning style, self-regulated learning skill and achievement motivation. Such help and effort, by school guidance counsellors, school authorities, parents and teachers, will go a long way to increasing students' mathematics achievement.

Keywords: Mathematics, Learning style, Self-regulated skill, Achievement Motivation

Introduction

In Nigeria of today, industrial and technological developments suffer displaced priority as a result of which there is an immense need to place a greater emphasis on their actualization. Students are therefore encouraged to develop interest in and pursue science related subjects

and courses as these will boost geometrically the level of development in these crucial fields in the nearest future. Mathematics is a basic pre-requisite for the learning of any science and other disciplines at all levels of education. It is compulsory for students in the science and other disciplines to have at least a credit pass in mathematics at the Senior Secondary School Certificate Examination in order to gain admission into a tertiary institution, to read science based subject or other profession.

As the queen and bedrock of all sciences, mathematics is obviously a sine-qua-non for effective scientific knowledge. It predisposes scholars in the scientific field to the skills of numeracy, measurement, calculation and construction without which the learning of science and science-based subjects may become more difficult to apply. The learning of mathematics is substantial in every field of human endeavour (Social Sciences, Natural Sciences, Engineering, Medicine and Education) and plays a fundamental role in economic development of countries.

For mathematics education to be meaningful, the students' academic achievement should be paramount. Ganai and Mohamed (2013) defined academic achievement as excellence in all academic disciplines, in class as well as co-curricular activities. The expectation of every student is to perform well in academic work. To attain this goal, effort and skill should be successful applied. This is often cognitive based and measured by examination or continuous assessment. The context of academic achievement in this study, will refer as students that is measured accomplishment in teacher- made- test. The students' academic achievement could be high or low; which means that it could either be good or poor. Despite the importance of mathematics, observations and reports from West African Examination Council Chief Examiners (WAEC, 2016), revealed that Nigeria secondary school students continue to perform poorly in mathematics examinations.

Many variables had been identified as being responsible for the poor academic achievement of students in mathematics. Such variables include government, curriculum, examination bodies, teachers, students, parents, home, textbooks and psychological factors (Olaoye, 2012). Having identified these factors, educators, researchers, as well as governments are keen to proffer solutions so as to reduce the poor academic achievement of students to the barest minimum. This makes all concerned researchers or educators to embark on the research to remedy the situation.

In the search towards industrial and technological advancement, we need nothing short of good academic achievement in mathematics to attain the Nigeria National Development Aspiration by the year 2030 (Zalmon & Wonu, 2017). For this reason, it is important to ensure lifelong learning for all, so as to enhance achievement in mathematics. To achieve this, Tigist (2013) believed that the classroom should now be learner centred instead of teacher centred. The new Nigeria secondary school mathematics curriculum (NERDC, 2007) is learner centred. In the learner centred classroom, the teacher acts as a facilitator who helps the learners to work on their project and to learn by doing (characteristics of a 21st century classroom, 2008). The variables/factors under focus in this study may promote lifelong learning among the students which may enhance their academic achievement in mathematics. These include: learning style, self-regulated learning skill and achievement motivation.

One of the basic psychological factors (of learning) that trained teachers learn in their educational training is that every learner has different learning style. This implies that every student is unique and has a unique way of solving problems. In a normal classroom, we have children of varying learning abilities. In learning abilities, Anusiem (2006) identified slow learners, fast learners or gifted learners. These learners have suitable styles they prefer to learn. Zhou (2011) defined Learning style as the manner and conditions under which learners most efficiently and effectively perceive, process, store and recall what they are attempting to learn.

Learning style is the most suitable ways individuals prefer to learn, perceive information, solve problems and respond to the learning environment. The learners' awareness of their learning style preference may help them to optimally develop their self-regulated learning strategies which may improve their academic achievement in mathematics.

The term, self-regulated learning skill can be used to describe learning that is guided by meta-cognition (thinking about one's thinking), strategic action (planning, monitoring and evaluating personal progress against a standard), and motivation to learn (Perry, Phillips, & Hutchinson, 2006). In addition, Zimmerman (2002) further described self-regulated learning as the degree to which students are meta- cognitively, motivationally and behaviourally active participants in their own learning process. The students tend to set goals and consciously plan their academic studies. Self-regulated learning instruction can occur in many subject areas. However, according to Metallodou and Vlachou (2007), mathematics is still perceived as a threatening area in which one requires the application of cognitive strategies. Dawn (2012) believed that teaching of self – regulatory skill must be instilled in the students to encourage the application of productive study skills and to build ones' self-efficacy and academic motivation in the area of mathematics. The interplay between self-regulated learning and academic motivation could be important in predicting a students' academic achievement.

Achievement motivation is an important concept in classroom learning and it may link to increased levels of academic achievement. A student who is academically motivated could be the one determined to succeed in academic work. It is in this recognition that Tella (2007) defined achievement motivation as a motive that leads to seeking success or the achievement of high standard of performance. The teachers could use teaching strategies that incorporate motivation to stimulate student's interest and enhance achievement motivation. If mathematics work is seen as too difficult, students may not attempt their work or may give up easily because of fear of failure and low hope for success. On the other hand, perceiving mathematics as too

easy is not beneficial because higher achieving students may become bored with material they feel is not challenging. Students that perceived mathematics as difficult subject may determine to academically motivate themselves because of fear of failure.

Studies have shown that some personality and learning variables such as learning style, self-regulated learning, achievement motivation, gender, and achievement level may have influence on students' achievement in mathematics (Bosman & Schulze, 2018; Ekuri & Offiah, 2018). However, there have been conflicting reports as to the relative and combined contributions of these variables on students' achievement (Mutua, 2015; Mutweleli, 2014). These contradicting reports coupled with the noticeable consistent poor academic achievement of students in secondary school mathematics has necessitated a further investigation of the relative and joint contributions of the three predicator variables, learning style, self-regulated learning skill and achievement motivation to students' achievement in secondary school mathematics. Hence this study is poised to find out the predictive powers of learning style, self-regulated learning and achievement motivation on students' achievement scores in mathematics.

Research Questions

The study provides answers to the following research questions:

1. What are the relative predictive powers of each of the three variables to students' achievement scores in mathematics?
2. What is the joint predictive power of the three variables to students' achievement scores in mathematics?

Hypotheses

1. There is no significant relative prediction of the three-predictor variables to students' achievement in mathematics.

2. There is no significant joint prediction of the three-predictor variables to students' achievement in mathematics.

Method

The study adopted a predictive correlational survey research design. This is a higher order correlational research design that extends the least-square association principle to the study of relationship between one dependent variable and two or more independent variables. The subjects were 882 SS2 students from fourteen secondary schools in Owerri Education Zone of Imo State. The researcher adopted the multi-stage but simple random sampling technique to draw the sample. The instruments used for data collection were Barsch Learning Style Inventory (BLSI), Self-regulated Learning Questionnaire (SRLQ) and Achievement Motivation Scale (AMS). The cumulative average scores of students' results were used as their academic achievement scores. The validity of the instruments was ensured through experts' (one from measurement and evaluation and two from science education) suggestions and guidance. A single-administration reliability and Cronbach Alpha ensured the reliability of BLSI (0.85), SRLQ (0.89) and AMS (0.81). The data collected were analysed using correlation coefficient as well as coefficient of determination for research question one and multiple regression analysis for research question two and null hypotheses at 0.05 alpha level with the aid of (SPSS) version 20.

Results

Table 1: Relative predictive powers of the independent variables

Variables	N	r	r^2	Predictive value (%)
Learning style	876	.137	.019	1.9
Self-regulated learning skill	876	.098	.010	1.0
Achievement motivation	876	.079	.006	0.6

Table 1 presents the relative predictive powers of the variables to the variance observed in students' achievement scores in mathematics. The result shows that learning style, self-

regulated learning skill and achievement motivation predicted 1.9%, 1.0% and 0.6% respectively to the variance observed students' achievement scores in mathematics.

Table 2: Multiple regression analysis between the variables

Variables	Multiple R	R-square	Predictive value
Predictor variables and Mathematics Achievement	0.153	0.023	2.3%

Table 2 presents a summary of the multiple regression analysis of the relationship between the variables when joined together. The result shows that secondary school students' learning style, self-regulated learning skill and achievement motivation jointly accounted for only about 2.3% of the variance observed in mathematics achievement scores of students.

Table 3: Significant prediction of predictor variables to mathematics achievement

Variables	N	r	r^2	F	Sig.
Learning style	876	.137	.019	16.749	.000
Self-regulated learning skill	876	.098	.010	8.468	.004
Achievement motivation	876	.079	.006	5.517	.019

From the result of the regression analysis as shown in Table 3, the statement of hypothesis 1 is rejected; implying that there is a significant relative prediction of the three-predictor variables to students' achievement in mathematics. This is because the p-values (Sig. = 0.000, 0.004, 0.019) are less than the 0.05 level of significance.

Table 4: Summary of the multiple regression analysis

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	2823.434	3	941.145	6.983	.000
Residual	117520.487	872	134.771		
Total	120343.921	875			

Table 4 presents a summary of the multiple regression analysis of the prediction of the variables when joined together. The prediction is significant as attested to by the multiple regression analysis carried out ($F = 6.983$; Sig. = 0.000, $p < 0.05$).

Discussion

From the result of data analysis, it revealed a weak positive relationship between learning style, self-regulated skill, achievement motivation of secondary school students and their mathematics achievement scores. This implies that an improvement in any of the predictor variables would lead to increased students' mathematics achievement and that learning style may not contribute much to the students' achievement but cannot be neglected or overlooked. Also, the result also shows that learning style, self-regulated learning skill and achievement motivation predicted 1.9%, 1.0% and 0.6% respectively to the variance observed students' achievement scores in mathematics.The findings also showed significant relative prediction of the three-predictor variables to students' achievement in mathematics.

The result on multiple regression analysis of the relationship between the variables when joined together. The result shows that secondary school students' learning style, self-regulated learning skill and achievement motivation jointly accounted for only about 2.3% of the variance observed in mathematics achievement scores of students. The relationship between the three-predictor variables and students' achievement in mathematics is significant as attested to by the multiple regression analysis carried out. This implies that other variables are contributing more to students' achievement in mathematics other than students' learning style, self-regulated learning skill and achievement motivation.

However, learning style had the highest significant positive relationship while achievement motivation had the least relationship with students' achievement in mathematics. Students' achievement in mathematics is not really a direct function of self-regulated learning skill and their achievement motivation. It appears students are not achievement better in mathematics not really for the sake of their learning style but probably for the lack of achievement motivation and inadequate self-regulated learning skill. The small predictive powers of self-regulated learning skill and achievement motivation suggests that self-regulated

learning skill and achievement motivation are significant to students' achievement in mathematics. The result is similar to that of Abdel-Aziz (2012) who reported that the correlation between the self-regulated learning skill, achievement motivation and achievement scores was statistically low. Nevertheless, the multiple regression model showed that the three predictors were able to explain together low percentage of the variance of mathematics achievement. Thus, in this study, the best predictor of students' achievement in secondary school mathematics is learning style. The fact that these variables related and predicted positively to students' achievement in mathematics indicates that there is need to help secondary school students overcome every problem associated with the variables. This will go a long way to increasing students' achievement in mathematics and at the same time help students to reduce the stress caused by failure.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. Students should regulate their learning and adopt appropriate learning styles to increase their mathematics achievement.
2. There should be continuous public enlightenment campaign on the importance of self-regulated learning skill, learning styles as well as achievement motivation. This enlightenment campaign should be carried out at all the government levels.
3. There is need to help secondary school students overcome every problem associated with self-regulated learning skill, learning styles. Such help and effort, by school guidance counsellors, school authorities, parents and teachers, will go a long way to increasing students' mathematics achievement and at the same time help students to reduce the stress caused by failure.

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Relationship Between Self-Regulated Learning Skill and Achievement of Secondary School Students in Physics in Enugu State

Nnaji, J. I.
Enugu State Ministry of Education, Enugu, Enugu State, Nigeria

&

Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
jn.okoli@unizik.edu.ng

Abstract

The study focused on the relationship between self-regulated learning skills and achievement scores of physics students in the secondary schools in Enugu state. Three research questions guided the study and three hypotheses were tested at 0.05 level of significance. The study adopted the correlational design. The study population comprised 1,304 SS2 physics students in Enugu Education Zone of Enugu state. A sample of 400 SS 2 physics students obtained using a multi-stage sampling was used in the study. The instrument for data collection was Self-regulated Learning Skills Scale validated by experts. The reliability of the instrument was established using Cronbach Alpha technique which yielded reliability coefficient of 0.73. The method of data collection involved administering the instrument to the students with the aid of research assistants. The data obtained were analysed using Pearson correlation coefficient. The results revealed that a significant low positive relationship existed between self-regulated learning and achievement scores in physics. There is also a significant low positive relationship between male students' self-regulated learning and their achievement score in physics. However, no significant relationship was found between female students' self-regulated learning and their achievement scores in physics. The study recommended that orientation exercises should be organized by educational stakeholders for students on the skills of self-regulated learning so as to have greater number of students improve on such skills.

Keywords: Self-regulated learning, physics, achievement, secondary school students

Introduction

The world is witnessing tremendous advancement in the area of science and technology. One of the major subjects necessary for such advancement is Physics. Physics deals with natural phenomena through the study of the nature of matter and energy. It attempts to help man understand the nature and structure of the universe. Branches within the field of Physics help us to study things in different ways and from different perspectives. The different fields

of Physics include: Acoustics, Astronomy, Astrophysics, Atomic physics, Biophysics, computation physics, cosmology among others.

The study of physics and other science subjects develops in the learner well defined abilities and values such as spirit of inquiry, creativity, objectivity and the courage to question (Federal Republic of Nigeria, 2004). In Nigeria, science education programmes are designed to enable the learner acquire problem solving and decision making skills and to discover the interrelatedness of the various science subjects such as the relationship existing between physics and health, agriculture, industry among others in the aspects of life.

Despite several efforts directed towards promoting the study of physics, students have continued to be inconsistent in their performance in external examinations. The report of students' performance in West African Examination Council (WAEC) physics examinations reveals that the number of students who passed physics from 2007-2018 at credit level is below 50% of the enrolled students in most of the years. The report from West African Examination Council for physics students in Enugu has remained poor. In 2013, the percentage of students who made credit pass in physics decreased drastically when compared to the previous year 2012. The percentage of students who made credit pass and above in physics also decreased in 2015 as compared to 2014. The number of students with credit passes from 2015 to 2018 has not been encouraging.

The inconsistencies reveal that there have not been persistent increases in the number of students passing physics across the years when compared to some other subject areas. Amuche, Amuche, Bello and Marwan (2014) reported that students' poor performance in physics examinations had been traced to a number of factors such as: shortage of physics textbooks in the library, inadequate laboratory facilities, insufficient time allocated for practical work, use of predominantly lecture method by physics teachers, use of too many technical

terms or terminologies in physics lessons, poor motivation of teachers, poor funding, and poor attitude of students towards the study of physics.

Efforts had been made by the Federal and state governments at improving the teaching and learning of physics in schools through building of science laboratories and provision of science equipment in the schools. Perhaps the lecture method of teaching commonly used by most physics teachers do not offer the students opportunity for active participation in the lesson and do not promote meaningful learning of physics concepts. It is hoped that making students take responsibility for their own learning through self-regulated learning may enhance students' academic achievement in physics.

Self-regulated learning is an active, constructive process whereby learners set goals for their learning and attempt to monitor, regulate and control their cognition, motivation and behaviour guided by their goals and contextual features in environment (Tang, 2012). Reports from a number of early studies on self-regulated learning show that self-regulated learners are familiar with and know how to apply series of cognitive strategies (rehearsal, elaboration, organization) which help them to attend, transform, organize, elaborate, and recover information; as well as be able to plan, control, and direct their mental processes toward achievement of learning goals.

Self-regulated learners show motivational beliefs and adaptive emotions such as a sense of academic self-efficacy (Banu, 2013), the adoption of learning goals, the development of positive emotion towards tasks (example joy, satisfaction, enthusiasm). Such learners have the capability to control and modify them to the requirements of the pre-set task and the specific learning situation (Loong, 2013). They plan and control the time and effort to be spent on tasks, and they know how to create and structure favourable environments, such as finding a suitable place to study and seeking help from teachers and classmates when they encounter problems. Self-regulated learners show greater efforts to participate in controlling and regulating

academic tasks, classroom climate, and structure; and are able to effect a series of volitional strategies aimed at avoiding external and internal distractions so that they maintain their concentration, effort and motivation in performing tasks (Banu, 2013). It has been found that a good mastery of self-regulatory techniques or skills has positive and significant correlation with academic achievement (Banu, 2013; Garrido-Vargas, 2012; Loong, 2013; Matuga, 2009).

Self-regulated learning has enabled students in the past to engage actively and take responsibility for their own learning. Hence, they tend to be more motivated and properly conceptualize the subject matters being learnt. It is thought that self-regulated learning may hold a beneficial boost for the learner as it provides many information-rich experiences that could be of great help to both male and female physics students. Since gender remains an issue in physics achievement, teaching and learning methods should enhance achievement across gender. This underscored the need to examine whether self-regulated learning would correlate achievement in physics irrespective of gender. Gender influence on academic achievement have remained inconsistent. The inconclusive results of gender predictions of achievement therefore, pose a problem that continually attracts the interest of researchers. Hence, gender was examined in this study.

Purpose of the Study

The purpose of this study was to investigate the relationship between self-regulated learning skills and achievement in physics by secondary schools students in Enugu state. Specifically, the study sought to find out the:

1. Relationship between self-regulated learning skills scores of students and their achievement scores in physics.
2. Relationship between male students' self-regulated learning skills scores and their achievement scores in physics.

3. Relationship between female students' self-regulated learning skills and their achievement scores in physics.

Research Questions

The following research questions guided the study:

1. What is the relationship between self-regulated learning skill scores and achievement scores in physics?
2. What is the relationship between male students' self-regulated learning skill scores and achievement scores in physics?
3. What is the relationship between the female students' self-regulated learning skill scores and achievement scores in physics?

Hypotheses

1. There is no significant relationship between self-regulated learning skill scores and achievement scores in physics.
2. There is no significant relationship between male students' self-regulated learning skill scores and achievement scores in physics.
3. There is no significant relationship between the female students' self-regulated learning skill scores and their achievement scores in physics.

Method

The design adopted for the study was correlational. The choice of correlation design was because the study established the relationship between self-regulated learning and students' achievement scores in physics. There are different institutions of higher learning in Enugu state. The population of the study was 1,304 senior secondary two (SS2) physics students in all the public secondary schools in Enugu state. The sample for the study was 400 SS2 physics students. A multi-stage sampling procedure was used compose the sample using purposive and simple random sampling.

The instrument for the study was Self-regulated Learning Skill Scale (SLSS). SLSS was a modified Motivated Strategies for Learning questionnaire (MSLQ) designed and developed by Paul R. Pintrich, David A.F. Smith, Teresa Garcia, and Willbert J. McKeachie in 1990. Students rated themselves on a seven-point scale from "not at all true of me" to "very true of me". Negatively worded items and the ratings have to be reversed before an individual's score can be computed. The result of the physics students in the second term examination in which the instrument was administered was collated. The instrument, the objectives of the study, the research questions and hypotheses were validated by two experts and one experienced physics teacher in secondary school for validation. The reliability of the instruments was established using Cronbach Alpha technique. This choice of Cronbach Alpha was because the instrument was polytomously scored. The instrument was administered once to forty (40) SS2 Physics students outside the study area. The scores of the students from the instrument were computed for reliability index using Cronbach Alpha. The coefficient of internal consistency obtained was 0.73.

The instrument was administered on a one on one basis to the students through the help of the four research assistants and the schools' physics teachers in each school that were used in the study having obtained permission from the school authority.

Data relating to the research questions were analysed using Pearson correlation coefficient to determine the nature and magnitude of relationship. The interpretation of the correlation is as follows: $r = .00$, no relationship, $r = \mp.01\ to\ \mp 0.20$, low relationship; $r = \mp.20\ to\ \mp 0.50$, slight to fair relationship; $r = \mp.50\ to\ \mp 0.70$, substantial relationship; $r = \mp.70\ to\ \mp 0.99$, high relationship and $r = \mp 1.00$, perfect relationship. The decision rule for testing the hypothesis is reject null hypotheses when the significant value (P-value) is less than 0.05, otherwise the null hypotheses were not rejected.

Results

Research Question 1: What is the relationship between self-regulated learning skill scores of students and their achievement scores in physics?

Table 1: Relationship between Students' Self-Regulated Learning and Achievement scores in physics

Source of Variation	n	Self-regulated learning r	Achievement in physics r	Remark
Self-regulated learning	400	1.00	0.045	Low Positive Relationship
Achievement in physics	400	0.045	1.00	

Table 1 shows that a very low positive relationship of 0.045 exists between self-regulated learning and achievement scores in physics.

Research Question 2: What is the relationship between male students' self-regulated learning skill scores and their achievement scores in physics?

Table 2: Relationship between male students' self-regulated learning and achievement scores in physics

Source of Variation	n	Self-regulated learning r	Achievement in physics r	Remark
Self-regulated learning	157	1.00	0.158	Low Positive Relationship
Achievement in physics	157	0.158	1.00	

Table 2 shows that a low positive relationship of 0.158 exists between male students' self-regulated learning and their achievement scores in physics.

Research Question 3: What is the relationship between the female students' self-regulated learning skill scores and their achievement scores in physics?

Table 3: Relationship between female students' self-regulated learning and achievement scores in physics

Source of Variation	n	Self-regulated learning r	Achievement in physics r	Remark
Self-regulated learning	243	1.00	0.037	Low positive Relationship
Achievement in physics	243	-0.037	1.00	

Table 3 shows that a low positive relationship of -0.037 exists between female students' self-regulated learning and their achievement scores in physics.

Hypothesis 1: There is no significant relationship between self-regulated learning skill of students and their achievement scores in physics.

Table 4: Test for significant relationship between students' self-regulation learning and achievement in physics

		Self-regulated learning	Achievement in physics
Self-regulated learning	Pearson Correlation	1	.100*
	Sig. (2-tailed)		.045
	N	400	400
Achievement in physics	Pearson Correlation	.100*	1
	Sig. (2-tailed)	.045	
	N	400	400

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4 shows that correlation coefficient of 0.045 between self-regulated learning and achievement in physics is significant P(0.045) < 0.05. Therefore the null hypothesis was rejected. Thus, there is significant relationship between self-regulated learning of students and their achievement scores in physics.

Hypothesis 2: There is no significant relationship between male students' self-regulated learning skill and their achievement scores in physics.

Table 5: Test for significant relationship between male students' self-regulation learning and achievement score in physics

Male		Male self-regulated learning	Male physics Achievement
self-regulated learning	Pearson Correlation	1	.158*
	Sig. (2-tailed)		.047
	N	157	157
Physics Achievement	Pearson Correlation	.158*	1
	Sig. (2-tailed)	.047	
	N	157	157

*. Correlation is significant at the 0.05 level (2-tailed).

Table 5 shows that correlation coefficient of 0.158 between male students' self-regulated learning and their achievement scores in physics is significant P(0.047)<0.05.

Therefore the null hypothesis was rejected. Thus, there is significant relationship between male students' self-regulated learning scores and their achievement scores in physics.

Hypothesis 3: There is no significant relationship between the female students' self-regulated learning skill and their achievement scores in physics.

Table 6: Test for significant relationship between female students' self-regulation learning and achievement score in physics

Female		Female self-regulated learning	Female physics Achievement
self-regulated learning	Pearson Correlation	1	.037
	Sig. (2-tailed)		.562
	N	243	243
Physics Achievement	Pearson Correlation	.037	1
	Sig. (2-tailed)	.562	
	N	243	243

Table 6 shows that correlation coefficient of 0.037 between female students' self-regulated learning and their achievement scores in physics is not significant P(0.562)<0.05. Therefore the null hypothesis was not rejected. Thus, there is no significant relationship between female students' self-regulated learning and their achievement scores in physics.

Discussion

Self-regulated learning according to Tang (2012) is an active, constructive process whereby learners set goals for their learning and attempt to monitor, regulate and control their cognition, motivation and behaviour guided by their goals and contextual features in environment. The students at the senior secondary level of education have had some experience in learning. Physics as a science subject often prove difficult for students. The students to overcome the difficulties associated with learning physics must over time have developed some collective and individual skills for learning physics. These skills whether setting goals, metacognitive self-regulation, monitoring and evaluation of self are all part of self-regulated learning.

Accordingly, when learners are in a problem situation and attempt to find solution to challenging tasks, they not only perform cognitive activities, they also set for themselves specific goals, arrange their activities, monitor their achievement during the problem-solving process and evaluate the efficiency of their actions (Seel, Ifenthaler, & Pirnay-Dummer, 2009; Wirth & Leutner, 2008). The processes of self-regulated learning can be greatly enhanced through serious engagement with learning activities. The results of this study support the findings of Sedigheh, Mohd and Reza (2012) when they reported that there was a positive meaningful relationship between SRL and students' achievement. The result of the study also supports the finding of Abrami, Wade, Pillay, Ofra, Bure, and Bentley (2007) who found out that the self-regulated learning positively correlated with achievement.

The study also revealed that there was a significant low positive relationship between male students' self-regulated learning and their achievement in physics. However, a non-significant low positive relationship existed between female students' self-regulated learning and their achievement in physics. The diverse nature of students' academic wants and individual differences among learners makes it hard to create an environment that could encourage self-regulated learning even for the most experienced teacher. The wants is most of the time different for male and female students. Male students who seem more inclined to science related subjects may devout more skills in the learning of physics concepts than females especially on the grounds of gender stereotyping in the teaching and learning of science.

Another explanation for the results of significant correlation between male students' self-regulated learning and achievement in physics is the issue of social support and feedback. One important way to help students be more self-regulative is through social support and feedback from teachers and peers as well. Patrick, Ryan, and Kaplan (2007) noted that students who were keen on using self-regulated learning were mostly those who received social support from their teachers and peers. The social support can be in the form of effective feedback

where-with teachers include information about what students did well, where they need improvement and how best they can improve in the area noted in the feedback. Such social support can easily be facilitated through peer help. Peer tutorials and help from other students can facilitate the learning of concepts. This is common with male students who may find more interest in learning physics than female.

Conclusion

It can be concluded from the findings of the study that self-regulated learning has significant relationship with students' achievement in physic.

Recommendations

In the light of the findings also, the recommends that:

1. The government should provide facilities such as libraries within school environment that students can use when engaging in self-regulated learning.
2. Orientation exercises should be organized by educational stakeholders for students on the strategies of self-regulated learning so as to have greater number of students improve on such skills.
3. Teachers should always encourage students to indulge in self-regulated learning activities while at the same time giving them tasks that will move them to engage in the practice and use of such skills.

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Availability of E – Learning Facilities for Science Education Programme in Federal Universities in South East Nigeria

Okoli, C. C.
Alex Ekwueme Teaching Hospital, Abakaliki, Ebonyi State, Nigeria
&
Osuafor, A. M.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
am.osuafor@unizik.edu.ng

Abstract

This study was carried out to ascertain the availability of e-learning facilities for science education programme in Federal Universities in South- east Nigeria. One research question guided the study while one null hypothesis was tested at 0.05 level of significance. Design of the study was a descriptive survey. Population of the study comprised all the 65 science educators in Federal Universities in South-East Nigeria. The entire population was studied without sampling due to the manageable size. Instrument for data collection was a check list which was validated by experts. The checklist was assessed for reliability using the Kendal Coefficient of concordance. It yielded a reliability estimate of 0.75 Data collected were analysed using frequency counts, percentages and chi-square. The findings of the study revealed among others that a greater number and percentage of the e-learning facilities are available in science education programme in Federal Universities in South-east Nigeria. More so, there is no significant difference in the mean ratings of science educators on the availability of e-learning facilities for teaching of science education courses in the Universities based on gender. The study recommended among others that science educators in the universities should constantly update their knowledge on new technologies available for teaching and learning through conferences, seminars and workshops.

Key words: Availability, E – learning facilities, Science education programme, university

Introduction

The emergence and explosion of Information and Communication Technology (ICT) over the past few years has brought drastic changes in the nature of the learning environment. This has brought a paradigm shift in the method of learning from traditional to modern where the teacher is seen as a facilitator of learning and the learners participating actively through the use of modern learning facilities. Science education programme was not left out in these developments in the Universities. The Science educators as professional teachers who impact knowledge necessary for effective performance in the science field are equally expected to

move in pace with these changes. Federal Republic of Nigeria (FRN, 2013) noted that science educators are required to be regularly exposed to innovations in their fields such as the use of e-learning facilities to be professionally competent, in addition to the basic and professional training received as educators in science. As agents of change through discoveries to improve human existence, science educators are not just expected to transmit knowledge in today's information driven society, but to be mentors and facilitators in helping students to navigate through the ocean of science and to learn electronically using electronic learning facilities.

Jegede (2005) defined electronic learning (e-learning) as the presentation and delivery of lessons using the electronic media such as the web, internet or other multimedia facilities like computer, projector, television, audio and audio visual cassette and radio disc. E-learning makes use of many technologies – some of which have been developed specifically for it, whilst others conveniently complemented the learning process. These technologies include communication facilities that are widely used in teaching and learning such as the use of email and instant messaging, message forums and social network tools that any internet user would use. E–learning facilities in education means integration of modern telecommunication equipment and Internet Communication Technology resources such as the computer, scanner, printer, internet, intranet, e-mail, video phone system, teleconferencing devices, Wireless Application Protocols (WAP), radio and microwaves, television and satellites, multimedia computer and multimedia projector in teaching and learning and in curriculum implementation. The relevance of e-learning facilities in science education programme in tertiary institutions is in terms of its usage for instructional delivery, assessment, research and hands – on experience. Adesoji (2013) noted such as, use of the facilities in video conferencing which permits real interaction to be like conventional classrooms even where the recipients are far apart, web conferencing that permits sharing of presentation, documents and application demonstration. Others are usage in audio conferencing for collaborative discussions that involve certain

number of persons, chat as in texts and graphic capabilities for information sharing, instant messaging for message delivery, white boarding for demonstration and co-development of ideas among others. The integration and the use of these facilities in educational delivery of universities therefore becomes imperative.

University education has been described as the highest level of tertiary education given to persons who are qualified for enrolment for a course after the post primary education; and having fulfilled the admission requirement (Ekpang, 2008). Public universities are owned and managed by federal and state governments. Initially, they were the only ones in existence until private universities were established under Federal Government Act No 19 of 1993 following the insurgency in demand for university education; and which encouraged private participation in university ownership (National University Commission, NUC, 1999). At university level, programmes are configured to achieve among others, the ability of individuals to contribute to national development through high level manpower training, develop intellectual capability to understand and appreciate the local and external environments and acquire both physical and intellectual skills to become self-reliant and useful members of the society (FGN, 2013). The performances of these universities are constantly evaluated, monitored and supervised by NUC to maintain set standards. Conscious of the comp (BSc) effectiveness endangered by globalization, university programmes were reviewed and ICT was integrated into the curricula to solve societal problems

University awards Bachelor of Science (BSc) Degree in Science education after four years training offering courses in areas of chemistry, physics, biology, integrated science, mathematics, computer science education among others. The objectives of Science education Programme in university as noted by NUC (2008) are to: enable students gain the concept of the fundamental unit of science, provide learning opportunities which will help the students

acquire experience in the basic skills for effective implementation of integrated science curriculum in the junior secondary schools and develop in students, the spirit of inquiry into living and non-living things and energy changes in the environment. However, these objectives of science education at university level of education could only be achieved if the necessary facilities for teaching and learning are available for instructional delivery.

The role of e-learning facilities in curriculum implementation is recognized by the Nigeria National Policy on Education where it stated that, "the government shall provide facilities and necessary infrastructures for the promotion of ICT and e-learning" (FRN, 2013 p.53). In the modern age therefore, availability of e-learning facilities for science education in universities are considered necessary.

Availability of e-learning facilities depicts the presence and accessibility of electronic devices that are applied in teaching and learning. These devices when applied offers powerful learning environment and can transform the teaching/learning process in a manner that students can manipulate them for active participation, even in a self-directed way. Ko and Rosen (2004) opined that instructors should be assisted with all the software required to deliver courses on-line using sites on the web that offer recordings, document articles and photo essays. This implies that electronic learning facilities should be provided with the enabling environment and connectivity, that makes it accessible to users.

Unfortunately, the availability and adequacy of e-learning facilities in Nigerian tertiary institutions are doubtful (Wokocha, Elechi, Babalola, Agbagbue, Adanma and Umah, 2017); Osuafor and Emeji (2012) and Gabadeen, Alabi and Akinnubi (2015) discovered that these e-learning technologies are relatively available to the teachers and students in Nigerian universities. Evidence available also shows that the educators are seriously challenged in the use of available ones owing to such factors as poor awareness of electronic learning facilities available for instruction, irregular power supply, poor bandwidth connectivity and poor

maintenance of available facilities for sustainability (Okoli, 2012). Science education programme is not an exception as the achievement of its objectives seems also threatened by the poor availability of these e- learning facilities. These problems to a great extent will likely affect the performance of science education students in catching up with the speed of innovations in the field of science during training and on graduation in performing their functions; both as teachers in implementation of science education curriculum using the modern e-learning facilities, and other science- related responsibilities in their environment. In fact, unavailability of e–learning facilities among science educators may hamper the achievement of the overall science education objectives in universities.

There is a great feeling that there could be a difference in the availability of these e-learning facilities in universities based on ownership and gender of science educators. Federal universities are expected to be more furnished with these e-learning gadgets considering the federal might in its funding and as an example to state and private institutions. It also seems that male science educators are more interested in the availability of electronic facilities for science discoveries and learning than their female counterparts are. Rupere (2006) discovered that women are less involved in e-learning activities than their male counterpart in rural Zimbabwe. Observably, in Nigerian society and African continent in general, it appears that women are less involved in the use of electronic gadgets than their male counterparts with younger ones showing more interest. However, Chiaha, Eze and Ezeudu (2013) reported that there was no significant difference in gender with regards to students' access to e- learning facilities.

Nevertheless, these issues of availability of e- learning facilities in science education programme and factors as ownership and gender as they affect it need to be empirically proven in universities in south- east Nigeria. This study therefore investigated these facts with the aim

of proffering suggestions to enhance the overall objectives of science education programme in federal universities in south- east Nigeria.

Purpose of the Study

The purpose of this study was to determine the availability of e-learning facilities for teaching in science education programme in federal universities in south- east Nigeria.

Research Questions

What are the e-learning facilities available for teaching in science education programme in federal universities in South east, Nigeria?

Hypothesis

This null hypothesis was tested as 0.05 level of significance. There is no significant difference in the mean rating of science educators on the e-learning facilities available for teaching in science education programme in federal universities in South east, Nigeria based on gender.

Method

The study was a descriptive survey, carried out in South-east, Nigeria. South East is one of the six geo-political zones consisting of the Abia State, Ebonyi State, Enugu State, Imo State and Anambra State. The population comprised all 65 science educators from three federal universities in South-East Nigeria namely; University of Nigeria Nsukka, Nnamdi Azikiwe University, Awka and University of Agriculture, Umuahia. The entire population was studied without sampling because the size is manageable. One research question guided the study, with one hypothesis tested at 0.05 level of significance. A checklist was used to elicit information on availability of e-learning facilities for teaching and learning in the universities. This contains 15 items with two response categories, available and not available. The checklist was assessed for reliability using the Kendal Co-efficiency of concordance otherwise known

as inter-rater reliability. It yielded a reliability estimate of 0.75.A period of two weeks was used by the researchers to collect data on the availability of the e-learning facilities in the universities. The research instrument was administered personally by the researchers with the help of three research assistants from each of the universities. Relevant data on the availability of the e-learning facilities in the three universities were obtained.

The data collected from the study were analysed using frequency, percentages and Chi-Square statistics. Frequency and percentages were used to answer the research question while Chi-square statistic was used to test the null hypothesis. Statistical Package for Social Sciences (SPSS) Version 21 was used to analyse data.

In taking decision on availability of the listed e-learning facilities, each item is equated to 100 percent. Any item of 50 percent and above was regarded as available and not available if below 50 percent.

Results

The results of the study are presented in Tables 1 to 3

Research Question 1: What are the e-learning facilities available for teaching in science education programme in federal universities in South-East Nigeria? Analysis of data for answering research question 1 is presented in Table 1.

Table 1: Frequency and percentages of the e-learning facilities available for teaching in science education programme in federal universities in South East Nigeria

S/N	E-LEARNING FACILITIES	AVAILABLE		NOT AVAILABLE		REMARK
		N	%	N	%	
1	Computers	42	70.0	18	30	Available
2	Projectors	36	60	24	40	Available
3	Internet	40	66.7	20	33.3	Available
4	Video tape	18	30	42	70	Not available
5	Audio tape	16	26.7	44	73.3	Not available
6	Instructional radio	15	25	45	75	Not available
7	Instructional television	17	28.3	43	71.7	Not available
8	Text messaging	56	93.3	4	6.7	Available
9	E-mail facilities	51	85	9	15	Available
10	Telephone	56	93.3	4	6.7	Available
11	CD/DVD ROM	54	90	6	10	Available
12	WhatsApp	48	80	12	20	Available
13	Facebook	40	66.7	40	33.3	Available
14	YouTube	26	43.3	34	56.7	Not available
15	Flash drive	49	81.7	11	18.3	Available

The data contained in Table 1 shows that out of the 15 facilities rated, 10 items were available and five not available, giving 66.7% availability for teaching science education in the Federal Universities in South-East Nigeria. A higher number and percentage, 56(93.3%), 56(93.3%), 54 (90 percent), 51(85%), 49(81.7%) and 48(80%) indicated that telephone/ mobile phone, instant text messaging, CD/DVD ROM, e-mail facilities, flash drive, and WhatsApp are available. Other available facilities are computers, internet, face book and projectors with 42 (70 percent), 40 (66.7 percent), 40 (66.7 percent) and 36 (60percent) respectively. On the other hand, some e-learning facilities, instructional radio, audio tape, instructional television, video tape and You- tube with 45(75percent), 44(73.3%), 43(71.7%), 42(70 percent) and 30 (56.7percent) respectively are not available for teaching.

Hypothesis 1

There is no significant difference in the responses of science educators on the availability of e-learning facilities in Federal Universities in South East Nigeria based on gender.

Table 2: Chi-Square Analysis of the Difference in the Responses of Science Educators on the Availability of E-Learning Facilities in Federal Universities in South East Nigeria based on gender

S/N	E-LEARNING FACILITIES	GENDER				Df	χ^2	P-VALUE	REMARK
		MALE		FEMALE					
		Available	Not Available	Availa-ble	Not avail-able				
1	Computers	22	0	20	13	1	3.082	0.096	NS
2	Projectors	20	7	16	17	1	4.052	0.064	NS
3	Internet	20	7	20	13	1	1.212	0.409	NS
4	Video tape	10	17	8	25	1	1.158	0.397	NS
5	Audio tape	10	17	6	27	1	2.700	0.144	NS
6	Instructional radio	10	17	5	28	1	3.793	0.073	NS
7	Instructional television	10	17	7	26	1	1.831	0.251	NS
8	Text messaging	27	0	29	4	1	3.506	0.120	NS
9	E-mail facility	27	0	24	9	1	8.663	0.003	S
10	Telephone	27	0	29	4	1	3.506	0.120	NS
11	CD/DVD ROM	27	0	27	6	1	5.455	0.028	S
12	WhatsApp	27	0	21	12	1	12.273	0.000	S
13	Facebook	20	7	20	13	1	1.212	0.409	NS
14	YouTube	16	11	10	23	1	5.071	0.036	S
15	Flash drive	27	0	22	11	1	11.020	0.001	S

The table revealed that the P-values for the e-learning facilities namely, computers, projectors, internet, video tape, audio tape, instructional radio, instructional television, text messaging, telephone and face book are greater than the critical p-value (0.05) hence the difference in opinion of the male and female science educators for the items are not significant. The p-value for e-learning facilities as e-mail, CD/DVD ROM, WhatsApp, YouTube and flash drive are less than the critical p-value (0.05). Based on item by item analyses the opinions of these science educators were found to be significant and the null hypothesis not rejected. Hence, there is no significant difference in the responses of male and female science educators regarding the availability of e-learning facilities in Federal Universities in South East Nigeria

Discussion of Findings and Implications

The findings of this study revealed that the available e-learning facilities in teaching and learning of science education in Federal Universities in South east Nigeria are text messaging, telephone, CD/DVD Rom, e-mail facilities, flash drive, WhatsApp, computers,

internet, projectors and face book as rated from the most to the least available. E-learning facilities as instructional radio, audio tape, instructional television, video tape and you tube were indicated by the science educators as not available for teaching in the federal universities in South east Nigeria. This indicates a fairly high availability level of 66.7 percent. The finding from this study is in line with Atsumbe (2012) and Gabadeen, Alabi and Akinnubi (2015) which revealed that e-learning technologies are relatively available to the teachers and students in Nigerian universities. This is also similar to Osuafor and Emeji (2015) discovery that some listed e- learning facilities that include computer, printer, computer laboratory and public address system were moderately available for science educators in teaching pre-service teachers in South-East Nigerian Colleges of Education. Emesi and Yellowe, (2018) also revealed that information and communication technology gadgets are moderately available for teaching and learning in faculties of education in Rivers State Universities. This is not surprising as provision of ICTs in educational institutions has been the priority of Nigerian government, to improve the availability and utilization of e-learning facilities especially in the higher institutions. This is to move in pace with global competitiveness and to achieve programmes objectives in line with international standards.

The high availability of text messaging, telephone/mobile facilities, WhatsApp among others is a reflection of the flare among people today for android phones which have many facilities that could be used in teaching and learning. CD/DVD ROMs, flash drives even text messaging facilities are always available as they could be used offline, in asynchronous mode for individual and student to student interaction after teaching. This is in line with Er, Ozden and Asifogulu (2009) assertions that in an asynchronous learning environment where internet facilities are not readily available, e-learning facilities enable students to actively participate in their own learning, giving them the opportunity to interact with their peer, provide peer feedback, and reflect on the status of their personal learning goals and outcomes. This present

study has also confirmed the observation of Meloni (2010) that asynchronous communication using e-learning is by far the more popular learning type because many of the learning tools are free, require minimal hardware, and are used at the student's pace.

However, it is also worthy to note that the unavailability of such e-learning facilities as internet, instructional radio, audio tape, instructional television, video tape and Facebook at 33.3 percentage level is not negligible and calls for attention. Tarus, Gichoya and Muumbo (2015) also discovered the poor availability of these e-learning facilities in Kenyan public universities and as highly challenging in the implementation of e-learning for achievement of programme objectives. This shows that African universities are having similar problems with availability of e-learning facilities for teaching and learning. The problem in availability of these facilities for instruction could be as a result of financial constraints among teachers, students and the university management, energy crisis and lack of operational e-learning policies necessary for steady on- line instruction in the universities.

Furthermore, there is no significant difference in the mean ratings of science educators on the availability of e-learning facilities for teaching of science education based on gender. This indicates that the ratings of both male and female science educators do not differ significantly on the availability of e-learning facilities for teaching of science education in federal universities in South east, Nigeria. This finding is in line with Chiaha, Eze and Ezeudu (2013) report that there was no significant difference in gender with regards to students' access to e- learning facilities in federal universities in South east Nigeria.

The findings of this study have implications for science educators to constantly update their knowledge on e-learning facilities available for application in instruction, governments and stakeholders in tertiary institutions in making internet facilities adequately available for increased usage level of some e-learning facilities that is applied at synchronous mode. The

findings also imply the need for management of universities to encourage male and female science educators to continually develop themselves in the usage of e-learning facilities through adequate provision of the required facilities in the departments with enabling environments for frequent use.

Conclusion

The findings of this study indicates that Federal Universities in South-east Nigeria operates in conformity with NUC guidelines and expectations on integration of e- learning facilities in teaching and learning, to solve societal problems in line with global standards and in achieving objectives of science education programme in Universities.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. Government should provide internet facilities and others that are not sufficient available, to be accessible to teachers and student in the universities. This is to ensure constant usage among teachers especially science educators and students in order to facilitate their e-learning activities.
2. Policy makers in the Ministry of Education should make regulations that will encourage the provision of e- learning facilities in universities by government and university management and for use in science education programme.

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Enhancing Students' Attitude in Physics through the Use of Combined Physical and Inquiry Virtual Laboratories in Secondary Schools in Enugu State

Onuh, C. C.
Peaceland College of Education, Enugu, Enugu State, Nigeria
onuhchris2000@yahoo.com

&

Okigbo, E. C.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
ec.okigbo@unizik.edu.ng

Abstract

Research has revealed low enrolment and poor performance in Physics among secondary school students. This study compared the effects of enhancing students' attitude in Physics through the use of combined physical and inquiry virtual laboratories in Enugu State, Nigeria. The study adopted quasi experimental research design, specifically, pre-test, post-test non-equivalent control group design was used. Two research questions guided the study and three null hypotheses were tested at 0.05 alpha level. The population of the study consists 3,206 SS2 students. 220 SS2 physics students formed the sample size. The sample was composed using two stage sampling procedure. The research instrument used in this study is Test of Science-Related Attitude Scale (TOSRA). The instrument and lesson plan were validated by three experts. The reliability index was established using, Cronbach alpha technique which yielded reliability coefficient of 0.81. Experimental group was taught using combined physical and inquiry virtual laboratory while the control group was taught using physical laboratory only. Data were collected by administering TOSRA to the participants as pre-test and post-test. The research questions were answered using mean and standard deviation, while the null hypotheses were tested using Analysis of Covariance (ANCOVA). The findings showed that the use of combined Physical and Inquiry Virtual Laboratories had positive effect on students' attitude when compared to the use of only physical lab. The use of combined physical and IVL enhanced the attitude of male physics students more than their female counterparts taught the same way. Based on the findings it was recommended that teachers should expose physics students to inquiry virtual lab activities so as to promote meaningful learning, discovery learning and learning by experience among students. Also teachers should make teaching and learning of physics gender friendly by adopting the use of CPIVL in teaching physics concepts.

Keywords: Physical Laboratory, Inquiry Virtual Laboratory, Attitude

Introduction

The growth and development of most nations are dependent on science, technology and mathematics education. Science is that organized body of knowledge, which enhances the

ability to acquire skills. It is a search for meaning or exploration of events in nature (Ifeakor 2006).Science and technology related subjects that would enable students have a substantial understanding of science and be able to apply scientific knowledge in solving problems in their ever changing society are Mathematics, Physics, Biology, Health Science, Introductory technology and Chemistry. Science and technology would be incomplete without physics. Physics is applied to almost every human activity, as every profession involves some elements of physics. The significance of physics has made it imperative for its inclusion in the Nigerian senior secondary school curriculum for science-oriented students (FRN, 2004). In spite of the importance of physics as a requirement for many specialized science and engineering courses at the tertiary educational institutions, students' performance at the secondary school level (high school) in Nigeria is not encouraging (Adegoke, 2011, WAEC, 2012, Yusuf, Gambari & Olumorin, 2012).

The performances of students in physics as a subject in the Senior Secondary School Certificate Examinations (SSSCE) in Nigeria from 2010 to 2019 have been discouraging. The percentage of students that passed physics at credit levels (A1 - C6) had consistently been less than 50% (West African Examination Council [WAEC] Report, 2012). This can be traced to poor performance in physics practical which accounts for 40% of the total marks in SSCE physics examination.

Electricity, Simple Pendulum, Momentum, Mass of Spring, and Geometric Optics are among the major practical concepts that are problematic. Research findings have confirmed that these concepts among the abstract and complex aspects of physics, which the students find difficult to learn, and some teachers find difficult to teach (NERDC, 1993; WAEC, 2015, 2016, 2017, 2018 & 2019). Students need practical experiences to enable them understand some abstract concepts in physics, therefore, effective use of laboratory equipment and facilities will

improve the mastery of physics concepts. However, most of the public secondary schools in Nigeria are faced with insufficient of laboratory and equipment which limits the teacher to perform just simple laboratory activity (Adejoh & Ityokyaa, 2009).

Physical experiments are rarely performed in some public secondary schools in Nigeria due to lack of equipment, facilities and other logistic problems (Adekunle & Hussaini, 2010). In addition, the cost of carrying out experiments, arranging the equipment and laboratory activities are laborious and much time consuming. Checking students' performance during the laboratory activities can be tasking and laborious especially when dealing with large class (Yuysuz, 2010). When taking these challenges into consideration, looking for appropriate alternatives becomes inevitable, hence, the use of inquiry virtual laboratory in supporting the traditional laboratory method or adoption in the absence of physical laboratory can be a logical one.

Inquiry virtual laboratory (IVL) is an interactive environment without real laboratory tools meant for creating and conducting simulated experiments (Babateen, 2011; Harry & Edward, 2005). According to Babteen, IVL provides students with tools and materials set on computer in order to perform experiments saved on CDs or on web site. IVL is a learning environment in which students convert their theoretical knowledge into practical knowledge by conducting experiments (Woodfield, 2005). The potential benefits of virtual laboratory environment for physics practical cannot be underestimated in the contemporary world. Virtual laboratory makes students become active in their learning, provide opportunities for students to construct and understand difficult concepts more easily. Furthermore, it affords the learners some opportunities to overcome mistakes that occur as a result of such laboratory conditions or misuse of the laboratory and enable them to easily overcome the possible dangers that can be seen in the real laboratory conditions. Pyatt and Sims (2012) explain that using virtual

laboratory increases motivation and desire for the lectures in the process of learning. It also provides an affordable, safe, easy and ideal working environment.

In review of empirical studies on virtual laboratory, Tatli and Ayas (2012) and Shegog, Lazarus, Murray, Diamond, Sessions and Zsigmond (2012) found significant improvement in the performance of students exposed to virtual laboratory than their counterparts in the conventional laboratory method. Flint and Stewart (2010) reported that virtual laboratory was less expensive and ten times faster than a traditional laboratory exercise yet achieved the same learning outcomes for students who were already familiar with laboratory techniques.

Tuysuz (2010) found that virtual laboratory package made positive effects on students' achievements and attitude when compared to conventional laboratory method. Attitude of students towards school subjects however, could influence their academic achievement in the subjects either positively or negatively irrespective of gender.

Gender issues have been linked with attitude and performance of students in academic tasks in several studies but without any definite conclusion. Some studies revealed that male students performed better than the female in science courses. For instance, Kost, Pollock and Finkelstein (2009) found that male students performed better than female in interactive physics, while Anagbogu and Ezeliora (2007) found that girls performed better than boys using science process skills method of teaching. However, Adeyemi (2008), Gambari (2010) and Orabi (2007) reported that gender had no influence on academic performance of students. Therefore, part of this study examined the influence of female and male students exposed to the same amount and types of experiences in physics practical using virtual lab package in order to determine whether gender have any influence on students' attitude.

Attitude can be viewed as a predisposition to respond in a favourable or unfavourable manner with respect to a given subject (Okobia & Ogumogu, 2012). Several research in

developed nations reported that students liked to work with simulation program. For instance, Josephsen and Kristensen (2006) investigated undergraduate chemistry students' response to the SimLab computer-based learning environment, the results revealed that students enjoyed working with it; they found it motivating, and realized that it created a lot of experience, which they believed could be remembered more easily. Pyatt and Sims (2012) reported that students showed preference towards the chemistry virtual laboratory than physical laboratory. From the foregoing, most of the earlier studies from developed countries indicate that virtual laboratory could be an effective instructional tool for enhancing students' performance in sciences. However, there is very little research on the effectiveness of virtual laboratory for conducting physics practical at the senior secondary school level in Nigeria. Virtual laboratory is a new innovation in Nigerian education system particularly at secondary school level; therefore, this study examined the effect of researcher developed virtual laboratory on the performance of secondary school students in physics practical in Enugu State, Nigeria.

Purpose of the Study

The purpose of this study was to determine the effect of use of combined physical and inquiry virtual laboratories on attitude and achievement of secondary school students in electricity. Specifically, the study sought to determine the:

1. Difference in mean attitude rating scores of secondary school students taught electricity using combined physical and inquiry virtual laboratories (CPIVL) and those taught with only physical lab.
2. Difference between mean attitude rating scores of male and female secondary school students taught electricity using combined physical and inquiry virtual laboratories (CPIVL).
3. Interaction effect of teaching approaches and gender on attitude of secondary school students in electricity.

Research Questions

The following research questions guided this study:

1. What is the difference between the mean attitude rating scores of SS 2 students taught electricity using combined physical and inquiry virtual laboratories (CPIVL) and those taught using only physical laboratory?
2. What is the difference between the mean attitude rating scores of SS 2 male and female students taught electricity using combined physical and inquiry virtual laboratories (CPIVL)?

Hypotheses

The following null Hypotheses were tested at 0.05 level of significance.

1. There is no significant difference between the mean attitude rating scores of SS 2 students taught electricity using CPIVL and those taught using physical lab only.
2. There is no significant difference between the mean attitude rating scores of male and female of SS 2 students taught electricity using CPIVL and those taught using physical lab only.
3. There is no interaction effect of teaching approaches and gender on attitude of secondary school students in electricity.

Method

Research Design

The design for this study is quasi-experimental. Specifically pre-test, post-test non-equivalent control group design was used.

Population of the Study

The population for this study consists of all senior secondary year two (SS2) physics students in all the 30 public senior secondary schools in Enugu Education Zone of Enugu

State. The population is 3,206 SS 2 physics students. This population comprises 1,648 males and 1,558 females.

Sample and Sampling Techniques

The sample for the study comprised 220 SS 2 physics students. For the selection, a two-stage sampling was adopted. First, a purposive sampling was used to obtain two secondary schools out of the 20 co-educational public schools in Enugu Education Zone. The schools was sampled based on equivalence in (laboratory facilities and manpower), school location (urban area, Enugu metropolis), school type (coeducational schools), and equipped computer laboratories (under the school net programme) (students and teachers' exposure to the use of computer in their schools). All the students offering physics in each of the two schools were used for the study.

Instrument for Data Collection

The instrument for data collection was Test of Science – Related Attitude (TOSRA). The TOSRA was used to collect data on student attitude in physics. The TOSRA consists of 30 items.

Validation of the Instrument

The TOSRA was subjected to face and content validation. The face and content validation was done by submitting the instrument together with the purpose of the study, scope, research questions and hypotheses to three experts.

Reliability of the Instrument

Trial testing of the TOSRA was done by administering the instrument to 30 SS2 physics students in Comprehensive Secondary School Akpasha, Nkanu West Local Government Area of Enugu State (school not in Enugu Education Zone). The data were used to estimate the reliability of the instrument using Cronbach alpha technique. An internal consistency

(reliability) of 0.81 for TOSRA was determined and this was considered high enough for the instrument to be used for data collection.

Method of Data Collection

The research instruments developed for this study was: Test of Science Related Attitude Scale. The TOSRA were given to the students by their regular physics class teacher before the commencement of the lesson and after the lesson, the TOSRA were collected back from the students by their class teacher and the scores were used for data analysis.

Method of Data Analysis

The data gathered from the administration of research instruments were analysed using quantitative statistics. The research questions were answered using mean and standard deviation. The null hypotheses for the study were tested using Analysis of Covariance (ANCOVA).

Results

Research Question One: What is the difference between the mean attitude rating scores of SS 2 students taught electricity using combined physical and inquiry virtual laboratories (CPIVL) and those a taught using only physical laboratory?

To answer research questions one; the attitude scores of students before and after treatment were analysed quantitatively using mean and standard deviation (SD).

Table 1: Mean attitude rating scores of students taught physics using CPIVL and physical lab only.

Group	N	Mean Pre-test	SD Pre-test	Mean Post-test	SD Post-test	Mean gain
Experimental	116	62.93	30.68	100.91	29.67	37.98
Control	104	66.23	44.67	86.11	35.54	19.88
Mean diff.		-3.30		14.80		18.10

Table 1 revealed that those taught physics with combined use of physical and inquiry virtual laboratories developed positive attitude towards the subject than their counterpart taught physics with physical lab only.

Research Question Two: What is the difference between the mean attitude rating scores of SS 2 male and female students taught electricity using combined physical and inquiry virtual laboratories (CPIVL)?

Table 2: Mean attitude rating scores of male and female physics student exposed to combined use of physical and inquiry virtual laboratories.

Group	N	Mean Pre-test	SD Pre-test	Mean Post-test	SD Post-test	Mean Gain
Male	64	63.84	30.68	108.95	14.12	45.11
Female	52	61.81	30.96	91.00	39.47	29.19
Mean Diff.		2.03		17.95		15.92

Table 2 shows that male students taught physics with use of combined physical and inquiry virtual laboratories developed higher positive attitude towards physics than their female counterpart exposed with the same treatment.

Hypothesis One: There is no significant difference between the mean attitude rating scores of SS 2 students taught electricity using CPIVL and those taught using physical lab only.

Table 3: Summary of ANCOVA test of difference in attitude rating scores of treatment groups

Source	Dependent Variable	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	post-test attitude	189697.740[a]	5	37939.548	151.209	.001
Intercept	post-test attitude	30906.017	1	30906.017	123.176	.001
Pre attitude	post-test attitude	142505.001	1	142505.001	567.956	.001
	post-test attitude	66.315	1	66.315	.264	.608
Method	post-test attitude	15934.377	1	15934.377	63.507	.001
Sex	post-test attitude	22917.610	1	22917.610	91.338	.001
method * sex	post-test attitude	929.884	1	929.884	3.706	.056
Error	post-test attitude	53694.442	214	250.909		
Total	post-test attitude	2183554.000	220			
Corrected Total	post-test attitude	243392.182	219			

From Table 3, F (1,214) = 63.507; P = 0.001< 0.05; thus, hypothesis one is rejected showing that there is a significant difference between the mean attitude rating scores students taught electricity using CPIVL and those taught with only physical lab. This is in favour of CPIVL group.

Hypothesis Two: There is no significant difference between the mean attitude rating scores of male and female of SS 2 students taught electricity using CPIVL.

From Table 3, F (1,214) =91.34; P = 0.001<0.05. Thus, hypothesis three is rejected. It was therefore concluded that there is significant difference in the mean attitude rating scores of male and female students exposed to CPIVL group. The male physics students had higher positive attitude than their female counterpart.

Hypothesis Three: There is no interaction effect of teaching approaches and gender on attitude of secondary school students in electricity.

From Table 5, F (1,214) = 3.706; P = 0.056 > 0.05. Hypothesis five is not rejected. This shows that there was no interaction effect between Teaching methods and gender on students' attitude towards physics.

Discussion of Findings

The results of hypothesis one shows that students taught physics with use of combined physical and inquiry virtual laboratories developed positive attitudes towards the course than those taught with physical lab only. This finding agrees with the earlier findings of Josephsen and Kristensen (2006), and Pyatt and Sims (2012) who reported that students enjoyed working with virtual laboratory, showed preference towards the virtual medium in their lab experiences, found it motivating, and gained a lot of experience, which they believed could be remembered more easily. The results also shows that there is gender effect on the attitude of male and female students exposed to use of combined physical and inquiry virtual laboratories. This finding agrees with earlier findings of Adeyemi (2008), Gambari (2010) and Orabi (2007).

On interaction effect of teaching methods and gender on mean attitude rating and achievement scores, the finding of this study showed that there was no significant interaction effect of teaching methods and gender on students' mean attitude rating and achievement scores in physics. This is because the difference in their performance was not significant. However, the performance of the male students was slightly higher than that of their female counterparts, even though it was not statistically significant. This slight difference in the performance of male students and their female counterparts could be as a result of the nature of instructions delivered to the students, which enabled both the male and female students to be actively involved during the teaching and learning process. However, the male students performed better than their female counterparts, even though it was not statistically significant. This difference in the score of male students and their female counterparts could be as a result of the student's disposition to learn, both male and female students had equal opportunity to participate actively, but maybe the male students were more determined to learn than their female counterparts. Though the female students made considerably good effort based on their results.

Conclusion

From the findings, it can be deduced that use of combined physical and inquiry virtual laboratories produced more positive effect on students learning outcomes. It is gender friendly and improves students' attitude towards physics. This package is therefore a better approach for teaching practical physics at senior secondary schools in Nigeria. Through the use of combined physical and inquiry virtual laboratories, practical content can be delivered in simplest, motivating and interactive manners. This could reduce the age long poor performance in physics practical in Enugu State.

Recommendations

Based on the findings of this study, and their implications, the following recommendations were made.

1. Physics teachers should be trained on how best to involve students in the use of combined physical and inquiry virtual group laboratories activity during physics practical instructions so as to facilitate students' attitude and achievement in the lesson. This could be achieved through seminars and workshops for teachers in secondary schools.
2. Teachers should make teaching and learning of physics gender friendly by adopting the use of CPIVL in teaching physics concepts especially electricity.

Educational Implications of the Findings

The findings of this study have implications for education particularly in teaching physics practical in secondary schools. The implications of this study border on development of more virile instructional approach for teaching physics practical. The study revealed that use of combined physical and inquiry virtual laboratories was more effective in enhancing students' attitude and achievement in physics than physical laboratory activity. This result implies that the current instructional approach used in teaching might have been partly responsible for student's poor performance in physics practical.

The finding of this study equally has implication for science teachers. The finding of the study showed that science teachers (physics teachers) may have been using methods that are not favourable to students' understanding of the subject, therefore they need to move from using teacher-centred to student-centred and co-operative instructional strategies like the inquiry virtual laboratory activity, since it can enhance students to understand practical

activities, this will make them to focus on the learning task and be able to cooperate well with their colleagues.

Furthermore, the findings of the study showed that male performed better than their female counterparts in physics practical. The implication of this finding is that most instructional approach used in teaching physics does take care of gender difference in students. Therefore gender has to be considered during instructional delivery so that both male and female students will have equal opportunity to learn.

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Test Anxiety as Correlate of Chemistry Achievement among Secondary School Students in Imo State

Akanazu, E. C.
Department of Chemistry, Alvan Ikoku Federal College of Education, Owerri, Imo State, Nigeria
drezeakanazuc@gmail.com
&
Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
jn.okoli@unizik.edu.ng

Abstract

This paper investigated test anxiety as correlate of secondary school students' achievement in chemistry in Imo State. Three research questions and three hypotheses guided the study. The study adopted a correlational survey design. The population of 16,302 comprised all senior secondary school class two Chemistry students in 295 public secondary schools in the six education zones in Imo State. Eight hundred and seventy-five (875) formed the sample size which were selected using multi-stage sampling procedure. The instrument used for data collection is Sokan Test Anxiety Scale (STAS). The Cronbach reliability coefficient for STAS is 0.78. To collect data for the research, the researcher first visited the schools and discussed with the principals to get permission to carry out the research. The instrument was administered on the students by the researcher with the help of five research assistants to facilitate easy administration of the instruments. The cumulative average scores of the student in their first, second and third terms were used as their academic achievement scores. The data collected from respondents were analysed using Pearson product moment correction coefficient and regression analysis via SPSS version 20. The results revealed that test anxiety related negatively and to students' chemistry achievement, although, the relationship was weak. This indicates that other factors are contributing more to students' achievement in chemistry other than their test anxiety. It was recommended among others that teachers should work on their students to do away with every form of anxiety during examinations.

Keywords: Chemistry, Achievement, Test Anxiety, Students, Anxiety

Introduction

Chemistry is a branch of science that finds applications at home and industry. According to Akpan (2016), chemistry is the study of matter and the changes that matter undergoes. It is a branch of science which deals with the study of the nature, composition and properties of matter and the changes matter will undergo under different conditions. Chemistry is an experimental science whose study involves exploration of relationship between theory and

experiment (Otor, 2013). The study of chemistry as a subject at the secondary school level helps students in developing basic science skills, knowledge and attitude-based competences required for problem solving in their environment. Therefore, a poor foundation in chemistry at the secondary school level may jeopardize future achievement in the subject. One of the major variables that measure an individual's success or failure in chemistry is academic achievement. Academic achievement is often cognitive based and measured by examination or continuous assessment.

The factors that affect academic achievement in chemistry have been identified by scholars. According to Usman and Memeh (2012), the factors that negatively affect chemistry achievement include students' background, their self-efficacy, lack of interest and negative attitude towards chemistry. Teacher related factors like poor teacher preparation, inadequate teacher qualification, inadequate instructional materials and adoption of poor teaching methods also play a role. In Nigeria, efforts are being made by researchers, government and non-governmental organizations to improve cognitive outcomes among chemistry students. Some of these efforts includes organization of conferences, seminars and workshops for both students and teachers, organization of quizzes for students as a motivational approach to learning, equipping the laboratory with modern laboratory equipment's and facilities among others.

As available evidence indicates, achievement in chemistry at the secondary school level remains low and unimpressive (Sarason, 2014). Factors that influence students' chemistry achievement at the senior secondary school are multivariate. The factors that have been identified to be responsible for low achievement in chemistry include; teachers' qualification, quality of instruction and attitude, social psychological factors and social environmental factors (Udoh, 2008). Among the factors affecting student's achievement in general, less attention has been paid to student's test anxiety (Busari, 2010). That is the factor under focus in this study

because much attention has already been paid on ameliorating the effects of such factors related to teaching method, materials, environmental and other teacher-related factors yet students' achievement in chemistry has remained low. The present research is poised to divert attention to a social psychology based factor as test anxiety and see how it relate to students achievements in chemistry.

Test anxiety is an important variable often related to academic achievement (Spielberger & Vagg, 2015) Anxiety is an unpleasant emotion experienced as dread, scare, alarm, fright, trepidation, horror or panic (Nadeem, Maqbool & Zaidi, 2012). Test anxiety implies the debilitating experiences of anxiety as described by Lewis, during the preparation for a test or during the test itself. Minimal amount of anxiety can mobilize human beings to respond rapidly and efficiently, but excessive amount of anxiety may foster poor response and sometimes inhibit response. Test anxiety makes it hard for students to concentrate on test and perform adequately. In chemistry, students are tested for both knowledge levels, skill acquisitions and attitudes. Test anxiety can adversely affect a chemistry student carrying out practical exercises, his or her attitudes specific to the materials, his or her peer groups and even the ability to record observations promptly and correctly. Hence, this study is suspecting that test anxiety may be a contributing factor to poor achievement in chemistry. Most studies done in Nigeria in this area concentrated on the relationship existing between self-efficacy and one or two variables (Adeyemo & Torubeli, 2008; Onyeizugbo, 2010). Such variables include self-concept, peer influence, attribution and so on. They failed to show the contribution of test anxiety. Most times the fear or anxiety of male and female students during examination or test differs. The present researcher is also suspecting that test anxiety may be gender sensitive in affecting academic achievements generally and in chemistry in particular. This is because social behaviours of male and female students may affect their test anxiety differently.

Consequently the researcher believes that such in-depth may reveal hitherto uncharted course in understanding academic achievements among chemistry students.

Statement of the Problem

The study of Chemistry as a subject at the secondary school level helps students in developing basic science skills, knowledge and competence required for problem solving in their environment. It is observed that secondary school students in Nigeria perform very poorly in Chemistry yearly. The dismal achievement of students in Chemistry over the years is a cause of serious concern. WAEC Chief Examiner's Report (2012-2017) showed consistent poor academic achievement of students in Chemistry over a period of six years. Efforts have been made by educational researchers to improve students' academic achievement especially in chemistry but adequate attention has not been paid to an affective component of learners such as test anxiety. The problem of this study, therefore, is the perennial poor academic achievement of secondary school students in chemistry despite robust efforts of teachers and researchers for an improvement. This could be due to the fact that the impact of an affective component of learners such as test anxiety on their academic achievement in the subject have not been examined. Therefore, this study on test anxiety as correlate of chemistry achievement among secondary school students in Imo State is considered imperative. The findings of this study will be of immense benefits to secondary school Chemistry students, Chemistry teachers, parents, administrators, government and future researchers. However, only senior secondary class II students in public secondary schools were involved in the study. Respondent variable is delimited to gender.

Research Questions

The following research questions guided the study:

1. To what extent does test anxiety of secondary school students relate with their chemistry achievement scores?
2. What is the relationship between test anxiety of secondary school male students and their chemistry achievement scores?
3. What is the relationship between test anxiety secondary school female students and their chemistry achievement scores?

Research Hypotheses

1. Test anxiety scores of secondary school students do not significantly correlate their chemistry achievement scores in Imo state.
2. Test anxiety scores of secondary school male students do not significantly predict their chemistry achievement scores in Imo state.
3. Test anxiety scores of secondary school female students do not significantly predict their chemistry achievement scores in Imo state.

Method

The study adopted a correlational survey design. The population of this study comprised all 16,302 senior secondary class two (SS2) Chemistry students in 295 public secondary schools in all the six education zones in Imo State. The sample size for this study is 875. The sample was drawn from the population of 16,302 SS2 Chemistry students in the selected schools in the education zones. The researcher adopted a multi-stage sampling to draw the education zones and the schools that were used for this study. The Sokan Test Anxiety Scale (STAS) was adapted to measure the test anxiety level of the students. This was done in terms of language modification. The STAS is a 25-item instrument measuring test anxiety expressed with statements concerned with ones feelings toward test of examination. A high index of score suggests anxiety disorder while a low index suggests the reverse. The Cronbach reliability

coefficient for STAS yielded 0.78. To collect data for the research, the researcher first visited the schools and discussed with the principals to get permission to carry out the research. The instrument was administered on the students by the researcher with the help of five research assistants to facilitate easy administration of the instruments. The cumulative average scores of the student in their first, second and third terms were used as their academic achievement scores. The data collected from respondents were statistically analysed using mean, standard deviation, and Pearson product moment correction coefficient and regression analysis were used in determining the significant relationship between the variables with the aid of SPSS version 20.

Results

Research Question 1.

To what extent does test anxiety of secondary school students relate with their chemistry achievement scores?

Table 1: Relationship Value for Test Anxiety and Chemistry Achievement

Variables	N	R	R^2	(%) Contribution
Test Anxiety	869	.034	.0012	0.12
Chemistry Achievement	869			

Table 1 shows that academic test anxiety had positive linear relationships with chemistry achievement given by R = .034. From the analysis, test anxiety contributed just 0.12% of variance in chemistry achievement (R^2 = .0012). The implication of this is that the more anxious the students are about chemistry test, the less they achieve poorly.

Research Question 2

What is the relationship between test anxiety of secondary school male students and their chemistry achievement scores?

Table 2: Relationship Value for Test Anxiety and Chemistry Achievement of Male Students

Variables	N	R	R^2	(%) Contribution
Test Anxiety	418	.024	.000057	0.0057
Chemistry Achievement	418			

Table 2 shows that academic test anxiety had positive linear relationships with male students' chemistry achievement given by R = .024. From the analysis, test anxiety contributed just 0.06% of variance in their chemistry achievement (R^2 = .000057). The implication of this is that the more anxious the male students are about chemistry test, the less they achieve poorly.

Research Question 3

What is the relationship between test anxiety secondary school female students and their chemistry achievement scores?

Table 3: Relationship Value for Test Anxiety and Chemistry Achievement of Female Students

Variables	N	R	R^2	(%) Contribution
Test Anxiety	451	.051	.0026	0.26
Chemistry Achievement	451			

Table 3 shows that academic test anxiety had positive linear relationships with female students' chemistry achievement given by R = .051. From the analysis, test anxiety contributed just 0.26% of variance in their chemistry achievement (R^2 = .0026). The implication of this is that the more anxious the female students are about chemistry test, the less they achieve poorly.

Research Hypotheses

H_{01}: Test anxiety scores of secondary school students do not significantly correlate their chemistry achievement scores in Imo state.

Table 4: Significant Correlation of Test Anxiety on Chemistry Achievement

Variables	N	R	T	Sig.	Remark
Test Anxiety	869	.034	.804	.422	Not Significant
Chemistry Achievement	869				

From the result of the regression analysis as shown in Table 4, the statement of hypothesis 1 is accepted; showing that test anxiety scores of secondary school students do not significantly correlate their chemistry achievement scores. This is because the p-value (Sig. = .422) is greater than the 0.05 level of significance.

H_{02}: Test anxiety scores of secondary school male students do not significantly correlate their chemistry achievement scores in Imo state.

Table 5: Significant Correlation of Test Anxiety on Male Students' Chemistry Achievement

Variables	N	R	T	Sig.	Remark
Test Anxiety	418	.024	.379	.705	Not Significant
Chemistry Achievement	418				

From the result of the regression analysis as shown in Table 5, the statement of null hypothesis 6 is accepted; showing that test anxiety scores of secondary school male students do not significantly correlate their chemistry achievement scores. This is because the p-value (Sig. = .705) is greater than the 0.05 level of significance.

H_{03}: Test anxiety scores of secondary school female students do not significantly correlate their chemistry achievement scores in Imo state.

Table 6: Significant Correlation of Test Anxiety on Female Students' Chemistry Achievement

Variables	N	R	t	Sig.	Remark
Test Anxiety	451	.051	.866	.387	Not Significant
Chemistry Achievement	451				

From the result of the regression analysis as shown in Table 6, the statement of null hypothesis 9 is accepted; showing that test anxiety scores of secondary school female students

do not significantly correlate their chemistry achievement scores. This is because the p-value (Sig. = .387) is greater than the 0.05 level of significance.

Discussion

The findings revealed a weak negative relationship between test anxiety scores of secondary school students and their chemistry achievement scores. This shows that an increase in test anxiety would lead to small decrease in students' chemistry achievement. From the result of the correlation analysis, there is no significant relationship between test anxiety scores of secondary school students and their chemistry achievement scores irrespective of gender. This is not surprising because anxiety is a highly unpleasant affective state similar to intense fear which can include feelings of threat, vague objectless fear, a state of uneasiness and tension, and a generalized feeling of apprehension. Individuals experiencing anxiety embody apprehension and avoidant behaviour that often interfere with performance in everyday life as well as in academic situations. Individuals that become highly anxious during tests typically perform more poorly on tests than low-test anxious persons, especially when tests are given under stressful evaluative conditions such as a post-secondary exam.

This result collaborated the result of Nadeem, M., Ali, A., Maqbool, S., & Zaidi, S.U. (2012) who carried out a study on the relationship between test anxiety and academic performance in secondary schools in Nyeri district, Kenya. The results showed that there was no significant relationship between test anxiety and academic performance. Their results indicated that there was a statistically significant difference between the levels of anxiety aroused by different subjects. They further found out that both boys and girls are equally affected by test anxiety. Onyeizugbo (2014) found out that, there was a correlation between anxiety levels and academic achievement, and that high anxiety levels had a negative impact on the quality of academic results recorded by students. The study also established that

students' encountered some high anxiety causing challenges which affect their ability to perform effectively, and girls were found to be more prone to high anxiety levels as compared to boys. The study recommended that, students should take responsibility to seek for anxiety management help from teacher counsellors, other teachers. Muola, J.M., Kithuka, M.R., Ndirangu, W.G., & Nassiuma, D.K. (2009) investigated the relationship between test anxiety and academic achievement. It was found that a significant negative relationship exists between test anxiety scores and students' achievement scores. Results showed that a cognitive factor (worry) contributes more in test anxiety than affective factors (emotional). Therefore, test anxiety is one of the factors responsible for students' low performance but it can be managed by appropriate training of students in dealing with the causative factors.

Conclusion

Based on the findings of the study, it was concluded that more than half of the students are anxious about chemistry achievement test. Secondary school students in the study area had an average achievement score in chemistry. The results of this study presented evidence of the existence of a relationship between test anxiety and chemistry achievement. It was found that test anxiety positively and insignificantly correlated chemistry achievement. Test anxiety however had weak correlation value meaning that to some extent test anxiety correlated chemistry achievement irrespective of gender. However, other factors are contributing more to students' achievement in chemistry other than their test anxiety.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. There should be continuous public enlightenment campaign on the importance of text anxiety. This enlightenment campaign should be carried out at the national, state and local government levels by the ministry of education.

2. Chemistry teachers should be sponsored on seminar and conferences associated with psychological constructs such as test anxiety by the government so as to encourage the students to maintain low level of anxiety.

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Effect of Guided Inquiry Teaching Method on Secondary School Students' Academic Achievement in Chemistry in Awka Education Zone

Amadi, V. E.
amadiebereveronica@yahoo.com

&

Okeke, S. O. C.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
soc.okeke@unizik.edu.ng

Abstract

The effect of guided inquiry teaching method on secondary school students' academic achievement in chemistry was investigated. Two research questions and three null hypotheses guided the study. Quasi-experimental design, specifically, pre-test post-test non-equivalent control group design was used in the study. The population of the study was 642 chemistry students in Awka Education Zone. The sample for the study comprised of 122 students. The instrument for data collection was Chemistry Achievement Test (CAT) validated by two experts in Science Education and Educational Foundations Departments and one experienced chemistry teacher. The reliability of the instrument was established using Kuder-Richardson formula 21 for CAT which yielded coefficient of internal consistency of 0.85. Data were collected by administering the instrument as pre-test and post-test before and after treatment respectively. The data obtained were analysed using mean, standard deviation and analysis of covariance. The results revealed that guided inquiry method was more effective than conventional method in facilitating students' achievement in chemistry. There was a significant difference between the mean achievement scores of male and female students in chemistry in favour of females. It was recommended that, chemistry teachers should adopt guided inquiry instructional method when teaching in order to enhance students' achievement in chemistry.

Keywords: Guided-inquiry, chemistry, achievement, acid, mixtures

Introduction

Chemistry is the study of matter and energy, and the interaction between them. It is an integral part of the science curriculum both at the senior secondary school as well as higher institutions. At the secondary school level, it is an introduction to a wide variety of fundamental concepts that enables students to acquire tools and basic skills useful at the advanced level. Chemistry studies the nature, composition, properties and applications of matter. It has become one of the most important disciplines in the school curriculum; its importance in general

education has gained worldwide recognition (Ejidike & Oyelena, 2015). Ejike and Oyelena asserted that, it is one of the compulsory subjects for one to study science/technology related courses in tertiary institutions. Importance of chemistry is felt most in engineering and medicine especially in quantitative and qualitative analysis hence, Sani (2011) noted that chemistry is the heart and nucleus of science.

Chemists are often found in agro-chemical, petro-chemical, plastic, cement and steel industries: the products which are very vital to the development of any nation. It has been emphasized by Gongden (2016), that chemistry has played a major role in science, technology and society, and it still does so today. There is hardly found anything in nature that chemistry does not have an influence or impact over. No wonder the assertion that without chemistry there will be no life. Unfortunately, the subject has always come under threat with poor performance by secondary school students in Nigeria (Gongden, 2016).

The issues of poor academic achievement seem to be the central issue in most science education research nowadays. Most of the researches (Muhammad, 2007; Nwagbo, 2015) aim at finding a lasting solution to students' continued poor achievement reported in science subjects including chemistry none of the studies however, to the best of the researcher's knowledge, has focused on the students' interaction with the learning materials, among themselves and the teachers and how this can affect their chemistry achievement. The researcher therefore saw the need to explore innovative methods such as guided inquiry to determine whether such approach that challenge the students and enhance whole interaction could significantly affect students' academic achievement in chemistry.

Guided inquiry teaching method has been described as problem solving, critical thinking and not mere personal assumptions. It is a method of teaching that involves probing, finding out, investigating, analysing, synthesizing, discovering, evaluating, questioning and thinking (Muhammad, 2007). Guided inquiry teaching method allows students/pupils to

engage in experimentation similar to that of real scientists. Through these activities of inquiry, teachers can encourage their students to expand their critical thinking skills and use their logic to derive answers from scientific quandaries. The use of inquiry method will help to ensure that students develop a deep understanding of science and scientific inquiry (Nwagbo, 2015). A guided Inquiry teaching method revolves around students learning through 'hands-on minds-on' activities. Instructional approaches that has been shown to be effective for improving student performance in science are active learning strategies.

Teaching methods such as inquiry teaching, problem solving, problem based learning and project based learning relies heavily on the effective use of the science process skills by students to complete an investigation (Colley, 2006). The method is based on the assumption that the subject is to be learnt actively by fully participating in the learning task. It is a method that leads to effective learning outcome that is meaningful to the learner (Muhammad, 2007). For the students to meaningfully engage in an inquiry, there is need for the teacher to practically involve the students from the planning stage to the evaluating stage. This could be done or achieved by the students and the teacher in locating and gathering information from many sources like reading materials, specimens and community resources.

Inquiry teaching is educative and experimental and produces a lot of fun and joy as students learn by doing. When children are engaged in doing some activities, it simply means that their hands are on the activities, the type of activities where they are manipulating, observing, exploring, and thinking about science using concrete materials

The conventional teaching method involves unidirectional flow of information/knowledge from teacher to the students and do not encourage process skill acquisition needed for proper understanding of chemistry principles, concepts and facts. Guisti (2008) referred to these conventional methods as teacher-centred approaches to learning in the sense that the teacher and those up in the educational hierarchy are considered as the possessor

of knowledge to be transferred to the students, and as such decides how the knowledge transfer takes place. The unidirectional flow of information in the conventional teaching method makes students passive and unable to construct meaningful knowledge in the teaching and learning of chemistry. In conventional method, only hardworking students can benefit from it. The classrooms in Nigeria are predominantly dominated by conventional method of instruction which does not encourage students-students interaction. The common use of conventional method is obviously due to the fact that it is suitable for teaching a large number of students and saves a lot of time. It also requires lesser skill on the part of the teachers who use the approach. Conventional method as a teacher-centred approach makes for students' passivity and could lead often times to poor academic achievement both for male and female students.

The influence of gender on achievement and students' attitude towards learning has remained a controversial and topical issue amongst educationists and psychologists. Eze (2008) found that gender had significant effects on students' achievement and attitude towards chemistry, and showed that male students achieved higher and have more positive attitude than their female counterparts did. However, Owoyemi (2007) asserted that students 'achievement and attitude towards chemistry course has 'nothing to do with whether the student is male or female. Adesoji and Babatunde (2008) showed that the difference between the mean achievement and attitude scores of female and male students was not statistically significant in chemistry. It is obvious that the influence of gender on students' academic achievement and attitude remains controversial and inconclusive. It is against this background that the researcher seeks to ascertain if the use of guided inquiry teaching method could improve students' academic achievement and boost their attitude towards chemistry using gender as a moderating variable.

Purpose of the Study

The purpose of this study was to find out the effects of guided inquiry teaching method on secondary school students' academic achievement in chemistry. Specifically, the study sought to find out the:

1. Difference between the mean achievement scores of students taught chemistry using guided inquiry teaching method and those taught using conventional method.
2. Difference between the mean achievement scores of male and female students taught chemistry using guided inquiry teaching method.
3. Interaction effect of teaching methods and gender on students' achievement scores.

Research Questions

1. What is the difference between the mean achievement scores of students taught chemistry using guided inquiry teaching method and those taught using conventional method?
2. What is the difference between the mean achievement scores of male and female students taught chemistry using guided inquiry teaching method?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students taught chemistry using guided inquiry teaching method and those taught using conventional method.
2. There is no significant difference between the mean achievement scores of male and female students taught chemistry using guided inquiry teaching method.
3. There is no interaction effect of teaching method and gender on students' achievement in chemistry.

Method

This study adopted a quasi-experimental design specifically a pretest-posttest non-equivalent control group design was used. The study was carried out in the selected secondary schools in Awka Education Zone of Anambra State, Nigeria. The population of the study consists of 642 (110 in Awka North and 532 in Awka South) senior secondary school year one chemistry students in the government secondary schools within the zone. The sample size is 122 SS1 students drawn using purposive sampling technique. The sample is made up of four senior secondary schools from the 17 co-educational schools within Awka South and Awka North. The schools were purposively sampled based on the availability of well-equipped chemistry laboratory. Simple random sampling (balloting without replacement) was applied to assign the four schools to experimental group and control group. The experimental group school 1 has 29 students with school two having 32 students while control group school one had 31 students with school two having 30 students.

The instrument for data collection was chemistry achievement test (CAT). CAT consists of 20 multiple choice items. Each question has four (4) options A-D which was scored 5 marks each. The CAT was validated by one lecturer in Science Education Department and another from the Department of Educational Foundations in Nnamdi Azikiwe University, Awka and an experienced chemistry teacher. The reliability of the CAT was established using the Kuder-Richardson 20 formula method which yielded the reliability coefficient of 0.85.

One week training programme was organized for the four chemistry teachers and their assistants in the sampled schools to assist in the study. They were required to meet two hours daily (3-5pm). When all the training/orientation sessions were completed, the experimentation commenced as follows:

Pre-test: After the one week training, the CAT was given to the experimental and control groups of the sampled schools as pre-test. The objective of this pre-test is to determine the level

of students experience about the topic to be introduced to them during the treatment and to see how this experience affected or varied after the treatment. The test was administered by the four trained chemistry teachers and their four assistants at the appropriate time allotted for the test.

Treatment: The experimental groups of SSI chemistry students were subjected to four weeks treatment using the guided inquiry method to teach separation techniques, acid, base and salt concepts where all materials needed were provided to students. These materials include different types of apparatus, acid, base, different types of salts and litmus paper. During the lesson, the students carried out different investigation on their own while the teacher guides and directs the lesson. The most important characteristic of the lesson is that, the lesson was "student centred". Activities were designed to encourage students to become more adapted to using science process skills such as observing, experimenting, analysing, synthesizing, and have more knowledge about separation technique, and acid, base and salt concept. The experiment was conducted using the schools' timetables and at their normal lesson periods for a duration of four weeks. The conventional method was employed for the control groups. The content of the lesson was the same as the treatment groups. What varied were the teaching method as well as the lesson plans guiding the teachers.

Post-test: At the end of the treatment exercise, post-test on chemistry achievement test (CAT) on separation and acid base and salt were given to the students, at the same time in both schools and the scripts were collected and marked.

The scores obtained from the pre and post-test were analysed using mean to answer the research questions while ANCOVA was used to test the hypotheses at the 0.5 level of significance. ANCOVA was used to test the hypotheses because it enabled the researcher to handle the error due to problem of non-equivalent groups. The decision rule was that when the

P-value is less than or equal to 0.05, the hypotheses is rejected; on the other hand, when the P-value is greater than 0.05, the hypotheses is not rejected.

Results

Research Questions 1: What is the difference between the mean achievement scores of students taught chemistry using guided inquiry teaching method and those taught using conventional method?

Table 1: Pre-test and Post-test Mean Achievement Scores of Students Taught using Guided Inquiry and Conventional Methods

Methods	N	Pre-test Mean	Post-test Mean	Gained Mean	Pre-test SD	Post-test SD
Guided inquiry	61	50.98	57.38	6.40	9.04	8.785
Conventional	61	48.77	49.51	0.74	8.85	9.777

Table 1 reveals that the students taught chemistry using guided inquiry had pre-test mean score of 50.98 and post-test mean score of 57.38 with gained mean 6.40 in chemistry, while those in the control group taught with conventional method had pre-test mean score of 48.77 and post-test mean score of 49.51 with gained mean 0.74.

Research Questions 2: What is the difference between the mean achievement scores of male and female students taught chemistry using guided inquiry teaching method?

Table 2: Pre-test and Post-test Mean Achievement Scores of Male and Female Students Taught using Guided Inquiry

Gender	N	Pre-test Mean	Post-test Mean	Gained Mean	Pre-test SD	Post-test SD
Male	28	51.96	56.96	5.00	11.32	6.286
Female	33	50.15	57.73	7.58	8.33	10.539

In Table 2, it is observed that the male students taught chemistry using guided inquiry had gained mean achievement score of 5.00 while the females had 7.58.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught chemistry using guided inquiry teaching method and those taught using conventional method.

Table 3: ANCOVA on test of Significant Difference between the Mean Achievement Scores of Students taught Chemistry using Guided Inquiry and Conventional Method

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	10276.703[a]	2	5138.352			
Intercept	324.799	1	324.799			
Pre-test	8388.179	1	8388.179			
Method	1044.366	1	1044.366	62.850	.000	S
Error	1977.395	119	16.617			
Total	360700.000	122				
Corrected Total	12254.098	121				

Table 3 shows that at 0.05 level of significance, 1df numerator and 122df denominator, the calculated F is 62.850 with P value of 0.000 which is less than 0.05. Therefore, the null hypothesis one was rejected. Thus, there is significant difference between the mean achievement scores of students taught chemistry with guided inquiry method and that of those taught with conventional method in favour of guided inquiry.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students taught chemistry using guided inquiry teaching method.

Table 4: ANCOVA on test of Significant Difference between the Mean Achievement Scores of Male and Female Students taught using Guided Inquiry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	3909.859[a]	2	1954.929			
Intercept	416.910	1	416.910			
Pre-test	3901.040	1	3901.040			
Gender	78.784	1	78.784	6.342	.015	S
Error	720.469	58	12.422			
Total	205450.000	61				
Corrected Total	4630.328	60				

Table 4 reveals that at 0.05 level of significance, 1df numerator and 60df denominator, the calculated F is 6.342 with P value of 0.015 which is less than 0.05. Therefore, the null hypothesis three was rejected. Thus, there is significant difference between the mean

achievement scores of male and female students taught chemistry with guided inquiry method in favour of females.

Hypothesis 3: There is no interaction effect of teaching method and gender on students' achievement scores.

Table 5: ANCOVA on test of Interaction Effect of Gender and Teaching Method on Students' Achievement in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	10378.199[a]	4	2594.550			
Intercept	113.627	1	113.627			
Pre-test	8424.571	1	8424.571			
Gender * Method	14.583	1	14.583	.910	.342	NS
Error	1875.899	117	16.033			
Total	360700.000	122				
Corrected Total	12254.098	121				

Table 5 reveals that at 0.05 level of significance, 1df numerator and 121df denominator, the calculated F is 0.910 with P value of 0.342 which is greater than 0.05. Therefore, the null hypothesis five was not rejected. Thus, there is no significant interaction effect of gender and teaching method on students' achievement in chemistry.

Discussion

The findings of research question one revealed that the guided inquiry method of instruction was more effective than conventional method in facilitating students' achievement in chemistry. There is significant difference between the achievement scores of students taught chemistry using guided inquiry and conventional method in favour of guided inquiry method. The differences in the achievement might have been because of the fact that students were required to find out facts for themselves, thereby imbibing the scientific processes involved in learning chemistry, which enabled them to perform better than their counterparts taught chemistry using conventional method. When students generate their own question, analyse and discuss their findings and finally construct their understanding, they seemed to understand their own information better than the ones the teachers introduced to them. The guided inquiry

method may have been more effective because the instructions were characterised by active involvement of students, thereby capturing the attention of the students and maximizing comprehension of the subject matter. This finding is in line with Ugwu (2014) who indicated that guided inquiry instructional method was superior to conventional instructional method in facilitating students' achievement in basic science. Aniaku (2012) also revealed that guided inquiry enhanced students' achievement in Biology more than unguided inquiry. The findings of this study also supports that of Adejo (2015) who revealed that chemistry students taught using inquiry teaching method performed significantly better than their counterparts taught using traditional teaching method.

The results of research question two showed that female students performed better than their male counterparts in chemistry. This could be as a result of different socialisation processes of male and female students in which female persons are expected to be more careful and observant when involve in activities than their male counterparts who tend to participate carelessly. The finding of this showed that female students performed significantly better than male students in chemistry. The finding contradict the finding of Okorie and Ezeh (2016) who found out that there is no significant differences in the achievement of males and females students when inquiry teaching method is used. The finding also contradict the finding of Adejo (2015) who reported that there is no significant difference in the chemistry academic performance between male and female students taught using inquiry teaching method.

Conclusion

It can be concluded from the findings of the study that guided inquiry positively improves students' achievement in chemistry. It engages students more actively than the conventional method adopted by most chemistry teachers.

Recommendation

Based on the findings of this study and their implications, the following recommendations are made.

1. In view of the fact that the guided inquiry method was more effective in teaching chemistry and enhancing student's achievement in chemistry, the Ministries of Education should ensure that authors incorporate guided inquiry methods in the instructional methods for secondary schools.
2. School authorities should promote the use of guided inquiry method in the teaching and learning of chemistry.

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Effects of Multimedia Integrated Instruction and Demonstration Method on Secondary School Students Achievement in Ecological Concepts in Udi Education Zone

Asuzu, J. I.
iykeharford74@gmail.com

&

Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
jn.okoli@unizik.edu.ng

Abstract

The study focused on the effects of multimedia integrated instruction and demonstration method of teaching on secondary school students' achievement in ecological concepts. Two research questions guided the study and three hypotheses were tested at 0.05 level of significance. The study adopted quasi – experimental design specifically, pre-test post-test design. The population of the study consisted of 3,054 secondary school year two (SS2) students offering biology in Udi Education Zone of Enugu State. The sample size for the study was 105 SS2 Biology students. The instrument used for data collection was Biology Achievement Test (BAT) validated by experts in Science Education and one experienced Secondary School Biology teacher. BAT reliability was established using Kuder-Richardson formula 20 which yielded reliability coefficient of 0.98. Data relating to research questions were analysed using mean and standard deviation while the hypotheses were analysed using analysis of covariance (ANCOVA). The findings of the study revealed that multimedia integrated instruction significantly improved students' achievement in ecological concepts and there was no significant difference between male and female students taught with the same method of instruction. Based on this, recommendations were made that seminars, workshops and orientation exercises should be organized by the government and educational agencies to familiarize teachers of biology with the approach of multimedia integrated instruction.

Keywords: Multimedia, demonstration, achievement, ecology

Introduction

Biology is a natural science that deals with the living world, how it functions and what these functions are, how it develops, how living things came into existence, and how they react to one another and with their environment. It is a prerequisite subject for many fields of learning (medicine, pharmacy, nursing, agriculture, forestry, biotechnology and nanotechnology) that contributes immensely to the technological growth of the nation. This includes

Biology is seen as one of the core subjects in Nigerian secondary school curriculum. Because of its importance, students enrol for biology in the senior secondary school certificate examination (SSCE) more than Physics and Chemistry. Biology is introduced to students at senior secondary school level as a preparatory ground for human development, where career abilities are groomed, and potentials and talents discovered and energized (Federal Republic of Nigeria, 2013). The quality and quantity of science education including biology received by secondary school students are geared toward developing future scientists, technologists, engineers, and related professionals (Kareem, 2003). In spite of the importance and popularity of Biology among Nigerian students, achievement at senior secondary school level has been poor.

The WAEC Chief Examiner's Reports show that the percentage number of students who passed at a credit level and above has continue to fluctuate and have not increased as expected. Conventional teaching methods adopted by the few biology teachers at senior secondary school level in Nigeria, have been identified as one of the major factors contributing to poor performance of students in biology (Ahmed & Abimbola, 2011; Kareem, 2003; Umar, 2011). The conventional teaching method is classroom-based and consists of lectures and direct instructions conducted by the teacher. These teacher-centred methods emphasize learning through the teachers' guidance at all times. Students are expected to listen to lectures and learn from them.

The teacher often talk to the students instead of encouraging them to interact, ask questions, or make them understand the lesson thoroughly. Most classes involve rote learning, where students depend on memorization without having a complete understanding of the subject. Just passing the tests, consisting of descriptions, matching, and other forms of indicators, is all that matters to complete the curriculum (Adegoke, 2011; Umar, 2011). The persistent use of this method makes students passive rather than active learners. It does not

promote insightful learning and long–term retention of some abstract concepts in biology like ecological concepts (Ahmed & Abimbola, 2011). Biology teachers usually adopt lecture method in teaching in order to cover the syllabus within the stipulated time and this does not give room for proper understanding of the subject. The WAEC Chief Examiners report (2016) noted that the rush over the topics to cover the scope could be responsible for students' poor performance in Biology. From research evidence, educators see the pressing need to reconsider the techniques and methods of instruction at senior secondary school level. In order to arrest students' attention, interest, curiosity, promote their long-lasting retention, future involvement and ensure outstanding performances, the use of activity stimulating and student-centred approach need to be embraced. One of the promising approaches, according to Adegoke (2010), involves multimedia presentations supported in visual and verbal formats supplemented with pictures, animations, texts, and narration.

This technology provides a learning environment that is self-paced, learner-controlled and individualized. The concept of ecology in Biology draws the attention of the researcher as a topic that needs eclectic instructional design approach for proper accommodation and assimilation of knowledge such as multimedia instructional strategy. Ecological concepts are one of the difficult concepts in Biology. Ecology is the study of interaction among organisms and their environment. WAEC Chief Examiners (2015) reported the inability of students to answer questions on ecology. Thus, the researcher wants to find out the relative effectiveness of multimedia integrated instruction as compared demonstration method of teaching (which is also a good method for teaching biology) on secondary school students achievement in ecological concepts.

Multimedia is defined as the combination of various digital media types such as text, images, sound and video into an integrated multi-sensory interactive application or presentation to convey a message or information to an audience. The power of multimedia lies in the fact

that it is multi-sensory, stimulating the many senses of the audience. It is also interactive, enabling the end users of the application to control the content and flow of information. This has introduced important changes in the educational system and impacted on the way information is communicated to the learners. With multimedia, the process of learning can become more goal oriented, more participatory, flexible in time and space, unaffected by distances and tailored to individual learning styles, and increase collaboration between teachers and students. Multimedia enables learning to become fun and friendly, without fear of inadequacies or failure. Multimedia can be defined as an integration of multiple media elements (audio, video, graphics, text, animation) into one synergetic and symbiotic whole that results in more benefits for the end user than any one of the media element can provide individually.

Similarly, Ogunbote and Adesoye (2006) expressed the view that multimedia technology adds new dimension to learning experiences because concepts are easier to present and comprehend when the words are complemented with images and animations. The authors further stated that it has been established that learners retain more when a variety of senses are engaged in impacting knowledge; and the intensity of the experience aids retention and recall by engaging social, emotional and intellectual senses.

Students' interest and retention could be aroused and retained through the use of multimedia instructional approach (Adegoke, 2010). Furthermore, Starbek, Eriavec, and Peklai (2010) reported that students acquire better knowledge retention and improved comprehension skills more than the other groups when taught genetics with multimedia. Similarly, they found that students who were taught food and nutrition at senior secondary school level, and pupils taught primary science at nursery and primary school levels using multimedia, performed better and had better retention than those taught with traditional methods respectively. Apart from the use of multimedia, demonstrations can be conducted to verify facts and concretize knowledge.

Demonstration means to clearly show by reason or proof; explaining or making clear by use of examples or experiments. In demonstration method, teachers and students are given opportunity to put their ideas and views together (that means that students are active in the learning process). Notwithstanding this benefit, if the class is large, all the students might not have the opportunity to participate. It can be said that in demonstration method, teachers really perform certain kinds of experiments. Students observe it and ask various kinds of questions concerning the experimental function performed by the teacher. After observation, students are required to explain every step taken by the teacher. Thus, the students feel a kind of compulsion to concentrate solely on the experimental processes conducted by the teacher.

Demonstration is the basic method for introducing new skills to the learners (Cyril, 2014). It consists of showing the learner how new skills should be performed. The teacher does the showing while the learner observes. The showing is accompanied by explanation on the part of the teacher of how the skill is demonstrated. Demonstration method of teaching can be used at all levels of education – primary, secondary and tertiary. The method demands certain level of skills, practice and appeals to many senses. It is a good method for introducing new skills, developing understanding and showing appropriate ways of doing things irrespective of gender.

Gender issues in the teaching and learning of biology has remained an inconclusive issue. Some of the factors that are front burners in the issue of gender and science learning is gender stereotyping as well as traditional practice. While some studies showed that certain instructional methods tend to favour male students, others maintain that female students are more favoured. It is pertinent to examine whether an approach to instruction favours male or females so that teachers could make necessary adjustments during lesson to ensure equity both in learning and achievement.

Purpose of the Study

The purpose of this study was to investigate the relative effectiveness of multimedia integrated instruction and demonstration method of teaching on secondary school students' achievements on ecological concepts in Udi Education Zone of Enugu State. Specifically, the study investigated the:

1. mean achievement scores of students taught ecology using multimedia integrated instruction and those taught using demonstration method.
2. mean achievement scores of male and female students in ecology.
3. interaction effect of instructional methods and gender on the achievement of students in ecology.

Research Questions

The following research questions guided the study:

1. What are the mean achievement scores of students taught ecology using multi-media integrated instruction and those taught using demonstration method?
2. What are the mean achievement scores of male and female students in ecology?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students taught ecology using multimedia integrated instruction and those taught using demonstration method.
2. There is no significant difference between the mean achievement scores of male and female students in ecology.
3. There is no interaction effect of instructional methods and gender on the achievement of students in ecology.

Method

The design of the study was quasi-experimental. The pre-test, post-test non-equivalent control group design was used. In the study, intact classes were used. The population of study was made up of 3,054 SS2 biology students in Udi Education Zone of Enugu State. The sample was made up of 105 SS2 Biology students (50 males and 55 females) obtained using a multi-stage sampling procedure. The instrument for data collection was Biology Achievement Test (BAT). The concepts taught cover the following: concepts of ecology and components of ecosystem, population studies, relationship between soil types and water holding effects of soil on vegetation and simple measurement of ecological factor. The instrument was validated by two lecturers and one experienced biology teacher in a secondary school. Their corrections were effected in the final copy of the instrument. The reliability of the instrument was determined using Kuder-Richardson formula 20 (KR-20) after administering same to forty students outside the area of the study. The coefficient of internal consistency obtained was 0.98.In the two co- educational schools chosen for the study, the Experimental Group I was exposed to multimedia integrated instruction while, the Experimental Group II was exposed to demonstration method of teaching. The two groups received the same lesson content. Before the treatment, the regular biology teachers were briefed and used as research assistants. Data relating to the research questions was analysed using mean and standard deviation. The hypotheses were tested at 0.05 alpha level using analysis of covariance (ANCOVA). The choice of ANCOVA was to eliminate the initial group difference among the students. The decision rule was that whenever the null hypothesis was less than 0.05, the null hypothesis was rejected, otherwise, the null hypotheses was not rejected.

Results

Research Questions 1: What are the mean achievement scores of students taught ecology using multi-media integrated instruction and those taught using demonstration method?

Table 1: Pre-test and Post-test Mean achievement Scores of Students taught Ecology using Multimedia Integrated Instruction and Demonstration Method

Source of Variation	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gain in Mean
MII	51	24.41	8.98	57.94	5.02	33.53
DM	54	26.11	7.31	51.85	5.77	25.74

Table 1 reveals that the students taught ecological concept using multimedia integrated instruction have pre-test mean achievement score of 24.41 with standard deviation of 8.98 and post-test mean achievement score of 57.94, SD of 5.02 with gained mean achievement score of 33.53, while those in the control group taught with demonstration method have pre-test mean score of 26.11, SD of 7.31 and post-test mean score of 51.85, SD of 5.77 with gained mean 25.74.

Research Questions 2: What are the mean achievement scores of male and female students in ecology?

Table 2: Pre-test and Post-test Mean achievement Scores of Male and Female Students in Ecology

Method	Gender	N	Pre-test Mean	Pre-test SD	Post-test Mean	Post-test SD	Gain in Mean
MII	Male	24	24.38	9.24	57.50	5.11	33.12
	Female	27	24.44	8.92	58.33	5.00	33.89
DM	Male	28	27.32	7.39	51.96	5.98	24.64
	Female	26	24.81	7.14	51.73	5.65	26.92

Table 2 reveals that the male students taught ecological concept using multimedia integrated instruction have pre-test mean achievement score of 24.38 with standard deviation of 9.24 and post-test mean achievement score of 57.80, SD of 5.11 with gained mean achievement score of 33.12, while the females have pre-test mean score of 24.44, SD of 8.92 and post-test mean score of 58.33, SD of 5.00 with gained mean 33.89. The male students taught ecological concept using demonstration method have pre-test mean achievement score of 27.32 with standard deviation of 7.39 and post-test mean achievement score of 51.96, SD of

5.98 with gained mean achievement score of 24.64, while the females have pre-test mean score of 24.81, SD of 7.14 and post-test mean score of 51.73, SD of 5.65 with gained mean 26.92

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught ecology using multimedia integrated instruction and those taught using demonstration method.

Table 3: ANCOVA on Main Effects of the Independent Variables on Achievement

Source of variation	SS	Df	MS	F	P-value	P ≤ 0.05
Corrected Model	1417.652[a]	4	354.413	13.745	.000	
Intercept	22716.217	1	22716.217	880.972	.000	
Pre-test	435.541	1	435.541	16.891	.000	
Gender	9.669	1	9.669	.375	.542	NS
Method	1090.036	1	1090.036	42.273	.000	S
Gender * Method	1.104	1	1.104	.043	.836	NS
Error	2578.539	100	25.785			
Total	319425.000	105				
Corrected Total	3996.190	104				

Table 3 also shows that at 0.05 level of significance, 1df numerator and 104 df denominator, the calculated F is 42.273 with P-value of 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. Thus, there is no significant difference in the mean achievement scores of students taught ecology using multimedia integrated instruction and those taught using demonstration method in favour of multimedia integrated instruction.

Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students in ecology.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 104 df denominator, the calculated F is .375 with P-value of .542 which is greater than 0.05. Therefore, the null hypothesis is not rejected. Thus, there is no significant difference between the mean achievement scores of male and female students in ecology.

Hypothesis 3: There is no significant interaction effect of instructional methods and gender on the achievement of students in ecology.

Table 3 further shows that at 0.05 level of significance, 1df numerator and 104 df denominator, the calculated F is .043 with P-value of .836 which is greater than 0.05. Therefore, the null hypothesis is not rejected. Thus, there is no significant interaction effect of instructional methods and gender on the achievement of students in ecology.

Discussion

The study revealed that multimedia integrated instruction significantly enhanced students' achievement in ecological concepts. This finding can be attributed to the fact the MII tends to engage many senses of the learner. As was observed in the study, the use of MII provided a rich learning experience for the students by engaging both their sense of hearing and that of sight. The use of MII also reduced cognitive load and abstraction inherent in the concepts taught. This made it easy to properly conceptualize what was taught. Another possible explanation for the findings of the study was that MII enabled students to link what was taught to the real world. The use of motion test, graphics and simulation videos gave them first-hand understanding of the concept taught.

The findings of this study is are line with that of Amosa (2014) who reported that students taught using multimedia instruction performed better than their colleagues in the conventional teaching method. The finding of the study is also in line with that of Aminu (2011) who showed that significant differences existed in favour of the multimedia group for students taught with multimedia and lecture method. The finding of the study also supports the view of Danebeth (2013) that multimedia instruction had significant effect on the academic achievement of students more than when traditional method was used.

The study revealed that no significant difference existed between the male and female students in the experimental group taught using multimedia integrated instruction. The observed non-significant difference in the achievement of male and female students in the experimental group could be attributed to the fact that the use of multimedia integrated

instruction equally enhanced the achievement of the male and female students. All the students irrespective of their gender were carried along during the lesson, thus, the uniform performance. Similar observation was made in respect of male and female students in the control group. No significant difference was also found to exist between the achievement of male and female students taught ecological concepts using demonstration method. The finding of the study contradicts that of Oriaklin and Igbudu (2015) that there was gender difference in academic achievement of students.

Conclusion

It can be concluded from the findings of the study that MII is more effective in improving male and female students' achievement in biology more than demonstration method.

Recommendations

The following recommendations are made based on the findings of the study:

1. Seminar, workshops and orientation exercise should be organized by the government and educational agencies to familiarize teachers of biology with the approach of MII.
2. Educational stakeholders should make provision for technological and multimedia facilities that could help biology teachers in the easy use of MII in the real-time classroom.
3. Biology students should be introduced to multimedia database that hold multimedia files on biology related concepts to help them access multimedia files on their own and improve learning.

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Effects of Use of Improvised Consumable Chemical Substances in Instructional Delivery on Secondary School Students' Achievement in Chemistry

Obidimma, O. A.
idimmababy@gmail.com
&
Osuafor, A. M.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
am.osuafor@unizik.edu.ng

Abstract

The study focused on the effects of use of improvised consumable chemical substances in instructional delivery on secondary school students' achievement in chemistry. Two research questions guided the study and three hypotheses were tested at 0.05 level of significance. The study adopted quasi-experimental design specifically, the pre-test post-test control group non-equivalent group design. The population of the study consisted of 12, 509 secondary school year one (SS1) students offering chemistry in Onitsha Education Zone of Anambra State. The sample size for the study was 101 chemistry SS1 students. The instrument used for data was Chemistry Achievement Test (CAT). The instrument was validated by lecturers in the Department of Science Education and Department of Educational Foundations, Nnamdi Azikiwe University Awka and one experienced chemistry teacher at Federal Science and Technical College, Awka. CAT reliability was established using Kuder Richardson 20 (KR20) which yielded reliability coefficient of 0.81. Data relating to the research questions was answered using mean and standard deviation and the hypotheses were tested using analysis of covariance (ANCOVA). The findings of the study revealed that the effects of the use of improvised consumable chemical substances on the achievement of chemistry students when compared to those taught using standard consumable chemical substances is not significantly different. The study recommended among others that chemistry teachers should use as an alternative to standard consumable chemical substances, improvised consumable chemical substances in the teaching and learning of practical chemistry.

Keywords: Improvisation, consumable chemicals, standard chemicals, achievement, chemistry

Introduction

Science is seen as a systematic study of the nature of the universe through observation, experimentation, measurement and recording. Science comprises basic disciplines such as chemistry, physics, biology and mathematics. Chemistry is one of the science subjects offered at the senior secondary school level in Nigerian (Federal Republic of Nigeria, 2013). Chemistry is a branch of physical science that studies the composition, properties and

behaviour of matter. Since it is a physical science, its teaching has to be standard, that is to say, that the teaching of chemistry requires creativity. It is a science that contributes to better health and living standard of humanity. This fact is illustrated in the areas of provision of healthcare, agriculture, environmental remediation, textile manufacturing and process industries (Nweze-Akpa, 2011). It is one of the science subjects upon which technological breakthrough is built and is the pivot on which the wheel of science rotates. Due to the achievements and contributions of chemistry to the well-being of mankind, the United Nations General Assembly declared 2011 as the International Year of Chemistry with broad theme "chemistry – our life, our future". This is with the hope to increase students' appreciation and understanding of chemistry, increase young people's interest in chemistry in meeting world needs and generate enthusiasm for a creative future of chemistry.

The study of chemistry is a requirement for further learning of a number of science-related professional courses such as medicine, nursing, engineering and pharmacy. In contemporary Nigeria, great emphasis is placed on science and technological development. As a result, students are being encouraged to take upscience-related subjects, hence the need for a scientific investigation. In spite of the relevance of chemistry to the nation, the study of chemistry in our secondary schools is bedevilled with poor performance (Uchegbu, Anozieh, Mbadiugha, Ibe & Njoku, 2015). There has been a consistent decline in the performance of students in public examinations conducted by the West African examination council (WAEC) and National Examination Council (NECO) in chemistry across the country over the years (Uchegbu, et al., 2015).

The poor performance of students in science subjects, particularly chemistry, has assumed a serious dimension as reported by West African Examinations Council (WAEC) Chief Examiner's report (2013-2016). The Chief Examiner's Report showed that the raw mean score of the 1,645,047 students who registered for chemistry in 2013 was 18.00 and 25.00 in

papers 1 and 2 respectively. In 2014 examination, their raw mean score was 18.00 in paper 1 and 29.00 in paper 2. In both 2015 and 2016 however, the students mean score in chemistry was below 50% indicating continuous poor performance for raw mean scores of students). Chemistry students according to the Chief Examiner's Report (2013-2016) have poor knowledge of acid and bases, are unable to report results of acid-base titration experiments, unable to make calculations on molar and mass concentration.

Experimental or practical exercises are indispensable in the learning and teaching of chemistry. However, the acquisition and storage of chemicals especially the consumable ones to be used for experiments is often an issue. Consumable chemical substances are those chemicals that scientists use recurrently. They are also chemicals that get used up or discarded which must be replaced regularly. Most of the consumable chemicals are quite expensive and storing them for a long period of time to ensure availability may otherwise lead to wastage. This is because most of the consumable chemicals expire within short periods of time. The expensive nature of the consumable chemicals is because of their high demand and low storage period. In most case, important consumable chemicals are produced on demand. For this reason, experiments involving acid and bases which are among the important consumable chemicals required for experiments at the senior secondary school level is not often conducted early enough in accordance to the scheme of work. Teachers in most cases would have to wait till examination is close at hand in order to teach students these experiments. This results in poor mastery of the skills and pre-requisite knowledge required for the experiments and this could be one of the major causes of poor achievement in chemistry in secondary schools.

The National Policy on Education (FRN, 2013) emphasized on the need for the teaching and learning of science processes and principles through the use of instructional resources. The policy recommends practical, exploratory and experimental methods of teaching. In this regard, Okebukola (2004) stated that the basic tools that science uses in the learning of science

processes are instructional materials. Studies have shown that the use of instructional materials improved achievement (George, 2008; Nwagbo, 2006; & Nnoli, 2014). Instructional materials are wide varieties of equipment and materials used for teaching and learning by teachers to stimulate self-activity on the part of the students. The teaching of chemistry without instructional materials may certainly result in poor academic achievement.

Despite the importance of instructional materials in the teaching/learning processes, evidence in literature shows that chemistry teachers teach without using them (Ityokyaa, 2010; Nnoli, 2014). One of the commonest reasons that chemistry teachers give for not using the instructional materials is that the prices of materials are not affordable and hence they are not available in schools (Achimugu, 2016). Galloping inflation in the country, foreign exchange rate are high and therefore makes it impossible for schools to purchase already made instructional materials which are often imported into the country. For these reasons and even more, chemistry teachers, therefore, have been called upon to be creative in improvising these instructional materials from Nigeria environments in the absence of standard ones.

The standard materials are conventional instructional materials that are imported or factory made laboratory equipment for science teaching. Examples are consumable laboratory chemicals, laboratory glassware, Bunsen burners, tripod stand, etcetera. However, if these conventional materials are not available or inadequate, they can be locally made using resources in the environment as an alternative. This is the idea which improvisation brings and teachers should adhere to the use of improvised materials in the absence of the standard ones.

Improvisation according to Ikwuanusi (2011) is the process or act of providing or using alternative instructional resources in the absence of a standard or already made one. Landu (2000) defines improvisation as an act of using materials from local environment designed either by the teacher, students or with the help of local personnel to enhance instruction. Improvisation of instructional resources in secondary school for the teaching and learning of

science especially chemistry cannot be overemphasized. National policy on education (2013) stated that the provision and use of available instructional materials for teaching lay a sound basis for scientific and reflective thinking among students. It enables the students to connect abstract concepts taught, to real life experiences known to them. It also encourages students towards the development of creative abilities, strengthens enquiry, discovery, and investigative methods in science. Furthermore, It provides a frame of reference on which students can key their attention during classroom activities, enables teachers to think of cheaper, better and faster methods of making teaching and learning process easier for students, affords students the opportunity of becoming familiar with resources in their environments.

Improvised instructional materials may not be exactly like the conventional one, therefore teachers should be skilful in handling and using them (Igwe 2003). It also requires a considerable development through imaginative planning and good knowledge. Some of these improvised instructional materials in chemistry include used electric bulb for round bottom flask, juices of unripe oranges, lime, grape, tomatoes, sweet potatoes, cocoyam corm as acids, solution of ash gotten from palm frond, cassava peels, "akanwu" as bases (improvised consumable chemical substances), candle or stove as burner, teaspoon for spatula, extract of coloured flowers as indicators and so on. Since the improvised consumable chemical needed to teach acid and bases may not look exactly like the standard ones, one wonders whether students could achieve the objective of instruction when they are used. The researcher is, therefore, poised to investigate the effects of the use of improvised consumable chemical substances in instructional delivery on secondary school students' achievement and retention in chemistry.

Purpose of the Study

The purpose of the study was to investigate the effects of the use of improvised consumable chemical substances (ICCS) in instructional delivery on secondary school

students' achievement in chemistry. The study sought to examine the:

1. Difference in the mean achievement scores of students taught chemistry using improvised consumable chemical substances (ICCS) and those taught using standard consumable chemical substances (SCCS).
2. Difference in the mean achievement scores of male and female students taught chemistry using improvised consumable chemical substances.
3. Interaction effect of instructional approach and gender on students' achievement scores.

Research Questions

1. What is the difference in the mean achievement scores of students taught chemistry using improvised consumable chemical substances (ICCS) and those taught using standard consumable chemical substances (SCCS)?
2. What is the difference in the mean achievement scores of male and female students taught chemistry using ICCS?

Hypotheses

1. There is no significant difference in the mean achievement scores of students taught chemistry using improvised consumable chemical substances (ICCS) and those taught using standard consumable chemical substances (SCCS).
2. There is no significant difference in the mean achievement scores of male and female students taught chemistry using ICCS.
3. There is no significant interaction of instructional delivery methods and gender on students' achievement in chemistry.

Method

The design of the study is quasi-experiment, specifically, the pre-test-posttest non-equivalent control group design. The area of study is Onitsha Education Zone of Anambra state, Nigeria. The population of the study comprised all 12,509 students (3,307 females and 9,202 males) senior secondary one (SS1) chemistry students in the 32 public secondary schools in Onitsha Education Zone of Anambra state (Source: Planning, Research and Statistics Department, Onitsha). The sample for the study is 101 SS1 chemistry students. The sample was obtained through a multi-stage sampling technique. First, with simple random sampling (balloting without replacement) two out of the three local government areas in Onitsha Education Zone were selected. With a flip of a coin, one of the local government areas was designated to be the area from which the experimental schools was selected and the other for school to be used as control groups. The schools in the local government areas were stratified according to single-sex and coeducational schools. From the two strata on co-educational schools, two schools were selected using simple random sampling (use of random numbers). The schools in each stratum on coeducational schools were arranged alphabetically. The serial numbers of the schools were listed on pieces of papers and two numbers selected without replacement. A total of fifty-two (52) students consisting of twenty-nine (29) males and twenty three (23) females in one school selected from the stratum from Onitsha South became the experimental group while the total number of forty nine (49) consisting of twenty-seven (27) males and twenty two (22) females from one school in the second stratum from Onitsha North became the control group.

The instrument for data collection is Chemistry Achievement Test (CAT). The questions were selected from the West Africa Examination Council (WAEC) past questions (Anyaele, 2017). CAT has twenty-five (25) multiple choice objective questions covering acids and bases. The questions have options lettered A-D for students to choose the correct option;

any correct answer earned the student four marks. CAT is divided into two sections; section A- designed to determine demographic information of the students and section B which contained the test questions**.** A table of specification or test blueprint was used to reflect questions from the different contents in acids and bases. The questions in the CAT were selected to cover the low and high order levels of the taxonomy of educational objectives developed by Bloom. This is because students are being introduced to separate sciences for the first time. Lesson plans designed with the use of instructional materials (standard and improvised consumable chemical substances) on the chemistry concepts of acids and bases were also developed. CAT was validated by two lecturers in the Department of Science Education and the Department of Education Foundation, Nnamdi Azikiwe University, Awka and to one experienced chemistry science teacher at Federal Science and Technical College Awka. The reliability of the CAT was established using the Kuder-Richardson formula 20 (KR-20). The instrument was administered on forty students (40) in Awka. The generated scores were computed for reliability using the formula which yielded a coefficient of 0.81.

The researcher visited the schools that were involved to obtain permission from the authorities concerned to use their SS1 students and their teachers in the study. The experiment was conducted in three phases. Phase one was the acquisition of the improvised consumable chemicals by the researcher and of the standard consumable chemical from the market in large quantities enough for experiments. Phase two was for the training of the researcher assistants who were the regular chemistry teachers in the schools to be used for the experiment. Phase three was the teaching of the students by the researcher assistants under the observation of the researcher. The training of two chemistry teachers from the selected schools who were used as research assistants was done in one week in three contacts.

The Improvised Consumable Chemical Substances (ICCS) were used to teach the experimental group. The research assistants were taught the use of improvised consumable

chemical substances to teach the concept of acids and bases. Improvised consumable chemical substances are those substances which are produced from organic materials within our environment mainly from plants. These chemicals served as instructional materials for the teaching of chemistry in the absence of standard chemicals; since chemistry is an experimental activity that requires the active participation of the students, teaching without using them may result to poor performance. The researcher gave out the lesson plan on the use of improvised consumable chemical substances on the two topics selected for the teachers to take home and study. The topics were acids and bases.

In the second contact, the researcher discussed each lesson plan giving explanations and classifications emphasizing that each topic in the lesson plan was introduced using the recommended instructional materials (Improvised Consumable Chemical Substances). The selected topics were taught for five weeks. In the third contact, the identification of acids and bases in the improvised consumable chemical substances was done by the researcher and research assistants. Oral evaluation to ensure that the teachers have mastered the procedures involved in the use of ICCS was carried out. Where the explanation was not clearly understood by the research assistants, the steps were re-discussed and clarified.

The Standard Consumable Chemical Substances (SCCS) were used to teach the control group. The research assistants were given a rehearsal on the use of standard consumable chemical substances to teach the concept of acids and bases. The standard consumable chemical substances are those chemicals which are factory produced for use. These chemical substances served as instructional materials for teaching chemistry which thus brought about active participation of students during teaching/learning process. The researcher gave out the lesson plan on the use of Standard Consumable Chemical Substances on the two topics selected for the teachers to take home and study. The topics are acids and bases.

In the second contact, the researcher discussed each lesson plan and gave explanations and classifications emphasizing that each topic in the lesson plan was introduced using the recommended instructional materials (consumable chemical substances) the selected topics were taught for five weeks. In the third contact, the identification of acids and bases in the standard consumable chemical substances was done by the researcher and research assistants. Oral evaluation to ensure that the teachers had acquired the procedures involved in the use of SCCS was carried out. Where the explanation was not clearly understood by the research assistants the steps were re-discussed and clarified.

Data relating to the research questions were analysed using mean. The hypotheses were tested using Analysis of Covariance (ANCOVA). This was to remove bias, which may be resulting from using intact groups whose equivalence on certain measures would not have been fully determined. The decision rule for the hypotheses was that whenever P-value was less than 0.05, the null hypothesis was rejected and wherever it was greater than 0.05, the null hypothesis was not rejected.

Results

Research Questions 1: What is the difference in the mean achievement scores of students taught chemistry using improvised consumable chemical substances (ICCS) and those taught using standard consumable chemical substances (SCCS)?

Table 1: Pre-test and Post-test Mean Achievement Scores of Students taught Chemistry using ICCS and those taught using SCCS

Source of Variation	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
ICCS	52	27.31	63.46	36.15	9.52	14.77
SCCS	49	28.47	65.82	37.35	9.96	13.16

Table 1 reveals that the students taught chemistry using ICCS in the instructional delivery had pre-test mean score of 27.31 and post-test mean score of 63.46 with gained mean 36.15 in chemistry, while those in the SCCS group had pre-test mean score of 28.47 and post-test mean score of 65.82 with gained mean 37.35. The ICCS group has higher spread of scores in the post-test than those in the SCCS group.

Research Questions 2: What is the difference in the mean achievement scores of male and female students taught chemistry using ICCS?

Table 2: Pre-test and Post-test Mean Scores of Male and Female Students taught Chemistry using ICCS

Gender	N	Pre-test Mean	Post-test Mean	Gain in Mean	Pre-test SD	Post-test SD
Male	29	28.10	62.53	34.43	8.80	14.86
Female	23	26.30	64.52	38.22	10.47	14.92

In table 2, it was observed that the male students taught chemistry using ICCS had pre-test mean score of 28.10 and post-test mean score of 62.53 with gained mean 34.43 in chemistry, while females had pre-test mean score of 26.30 and post-test mean score of 64.52 with gained mean 38.22. There was higher score variation among the females than among the males in the post-test.

Hypothesis 1: There is no significant difference in the mean achievement scores of students taught chemistry using improvised consumable chemical substances (ICCS) and those taught using standard consumable chemical substances (SCCS).

Table 3: ANCOVA on Difference in the Achievement Scores of Students taught Chemistry using ICCS and SCCS

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	651.511[a]	4	162.878			
Intercept	26651.656	1	26651.656			
Pre-test	342.524	1	342.524			
Method	168.688	1	168.688	.867	.354	NS
Method*Gender	118.993	1	118.993	.603	.439	NS
Error	18932.647	96	197.215			
Total	220525.000	101				
Corrected Total	19584.158	100				

Table 3 shows that at 0.05 level of significance, 1df numerator and 100 df denominator, the calculated F is 0.867 with P-value of .354 which is greater than 0.05. Therefore, the null hypothesis one is not rejected. Therefore, the effect of the use of improvised consumable chemical substances (ICCS) in instructional delivery on students' achievement in chemistry is not significant when compared to that of those taught using standard consumable chemical substances (SCCS).

Hypothesis 2: There is no significant difference in the mean achievement scores of male and female students taught chemistry using ICCS.

Table 4: ANCOVA on Significant Difference of ICCS on Male and Female Students' Achievement in Chemistry

Source of variation	SS	Df	MS	F	P-value	Decision
Corrected Model	388.400[a]	2	194.200			
Intercept	14349.784	1	14349.784			
Pre-test	338.163	1	338.163			
Gender	28.230	1	28.230	.129	.721	NS
Error	10738.523	49	219.154			
Total	109350.000	52				
Corrected Total	11126.923	51				

Table 4 shows that at 0.05 level of significance, 1df numerator and 51 df denominator, the calculated F is 0.129 with P-value of 0.721 which is greater than 0.05. Therefore, the null hypothesis two is not rejected. Therefore, the effect of ICSS on male and female chemistry achievement is not significant.

Hypothesis 3: There is no significant interaction of instructional delivery methods and gender on students' achievement in chemistry.

Table 3 also shows that at 0.05 level of significance, 1df numerator and 100 df denominator, the calculated F is .603 with P-value of 0.439 which is greater than 0.05. Therefore, the null hypothesis seven is not rejected. Therefore, there is no significant interaction effect of teaching methods and gender on students' achievement in chemistry.

Discussion

The study revealed that the effect of improvised consumable chemical substances on students' achievement is not significant when compared to the use of standard consumable substances in instructional delivery using pre-test post-test scores. The finding of the study implies that the use of improvised consumable chemical substances is as effective as the use of standard consumable chemical substances in enhancing students' achievement in chemistry. This observation from the finding of the study could be attributed to the fact that the improvised consumable chemical substances produced the same results as the standard consumable chemical substances.

The important thing is that the chemicals of the same make-up bear the same properties. The physical properties may differ markedly, but since the chemical components and functional groups required from the common experiments are the same, the same results are produced (Igwe, 2003). Take for instance, in the use of litmus paper to identify the substances which are acids and bases. Whether the consumable chemical used is improvised or standard, there is the presence of hydroxyl ion for base and hydrogen ion for acids. Thus, a litmus paper dipped into the two consumable chemicals will give the same results. Just so, the same results will be observed if the improvised and standard consumable chemicals were used in an experiment.

Another possible reason for the finding of the study is that students may not have been able to differentiate between standard and improvised consumable chemicals. What matter to

the students is what the teacher present to them in the classroom or the laboratory. The use of different chemicals which gave the same results for them is all practical exercise. There was no worry as to whether the consumable chemicals were improvised or standard. The interest of the students remained on what was to be learnt.

The finding of the study is line with the finding of Oladejo et al. (2011) who reported that there was no significant difference in the achievement of students taught using standard instructional materials, those taught with improvised instructional materials and those taught without instructional materials. The finding of the study also lend support to that of Ibrahim (2012) there was no significant effect of gender on students' achievement in physics. Finally, there was no significant difference between post-tests mean scores of males and those of females taught using improvised instructional materials. The finding of the study however contrast that of Mberekpe (2013) who reported that students taught using improvised instructional materials performed better than students taught using conventional material.

Conclusion

The study concluded that improvised consumable chemical substance is as effective as the use of standard consumable chemicals substance in the teaching and learning of chemistry.

Recommendations

In the light of the findings, therefore, it is recommended that:

1. Chemistry teachers should use as an alternative to standard consumable chemical substances, improvised consumable chemical substances in the teaching and learning of practical chemistry.
2. Seminars should be organized by the Science Teachers Association of Nigeria (STAN) on how chemistry teachers could use improvised consumable chemical substances to achieve similar results as standard consumable chemical substances.

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Effect of Collaborative Instruction on Secondary School Students' Achievement in Computer Studies in Imo State

Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria
jn.okoli@unizik.edu.ng

&

Ekebosi, C. A.

Abstract

The study investigated the effects of collaborative instruction on secondary school students' achievement in Computer studies in Mbaitoli L.G.A. of Imo State. The study was guided by two research questions and two null hypotheses tested at 0.05 level of significance. Design was quasi-experimental specifically the pre-test, post-test design that involved 80 JS3 students from the two secondary schools randomly selected using balloting from 14 government owned co-educational secondary schools in Mbaitoli L.G.A of Imo state. The students in their intact classes were randomly assigned to experimental group and control group by a toss of coin and were taught by their regular class teachers trained for the purpose. All the groups were pre and post tested, data were collected using validated Computer Achievement Test (CAT). The reliability estimate of 0.82 using Kuder Richardson formula 20 was obtained for CAT. The data obtained were analysed using mean, Analysis of Covariance (ANCOVA), and standard deviation. The result of data analysis indicated that collaborative instruction enhanced students' achievement in computer studies than the conventional method. The study also revealed that there were no significant differences in the mean achievement scores of male and female students taught computer studies using collaborative instructional method. Based on the findings, the researcher recommended that computer studies teacher should adopt collaborative teaching method since it enhanced students' achievement in computer studies so as to develop more knowledge and skill in computer studies students.

Keywords: Collaborative instruction, Computer Science and Achievement

Introduction

The role of computer in scientific and technological development has been established because it is used in almost all fields of human endeavour such as education, medicine, agriculture and engineering. Computer has changed lives in many ways and is expected to also change schools and education in general. As the world lives in Information and Communication Technology (ICT) era, and in a rapidly changing economy, schools should equip students with computer knowledge that will allow them to fully participate in the rapidly changing economy. Today, most schools have computers installed in their laboratories. However introducing

computer into schools generated new opportunities and challenges and it is difficult to find conclusive evidence on the positive effects of computer on students' learning outcomes. The learning outcomes can be ascertained with students' academic performance.

Student Academic Performance in any particular area of learning is an important factor in education. Thus, Okoli J.N. & Okeke I.S. (2018) defined performance as the accomplishment of academic goals, the educational outcome of students, or rather the extent to which a student, a teacher or an instructor has achieved the stated educational objectives. In this regard, Student Academic Performance can be described as the extent to which students meet the pre-set short or long term specific instructional objectives or educational goals. This is usually measured by continuous assessment or/and examination. It is one of the measures/ indicators of the quality of teaching-learning process in schools. This implies that the quality of teaching-learning process seriously affect the outcome of students' performance in continuous assessment or examination. Factors that affect students' academic performance are numerous and have gained increased attention of educators and researchers in education in the recent times. Directly or indirectly, it forms the theme and sub-themes of research work published in both local and international journals. One of such factors is the method of teaching and learning.

Teaching methods or instructional strategies have been defined by some scholars in education. Duru (2011) defined it as the mode by which material fact is communicated from teacher to the learner. According to Izuegbunam (2018) a teaching method comprises the principle and methods used for instruction to be communicated by teachers to students to achieve the desired learning objectives. In this study, teaching method is defined as the pedagogical activities and strategies through which the teacher imparts the desired knowledge and skills to students during teaching-learning process. There are many teaching methods which a teacher can use depending on the concept to be taught. Several factors affect the

selection of teaching method. The factors include: educational objectives, nature of subject matter, cost implication, size of class, available time, age of the students and their interest (Ughammadu, 2006). This means that for the appropriate teaching method to be selected and utilized, the teacher should be well informed about these factors. Despite the volumes of research work in the areas of factors that affect students' academic performance, there is still need for further empirical research in areas of determining teaching method that will be most suitable for teaching computer studies and other areas of science subjects, which students consider as difficult in order to achieve the desired result and also bridge the gender gap in education.

Recently in Nigeria educational system, Computer Studies at Junior Secondary School level was merged with other subjects such as Physical and health Education, Basic Science and Basic Technology; and called Basic Science and Technology. Despite the fact that they were merged as one subject, presently they are still being taught separately by specialized teachers from each of these four major areas. The content of the curriculum of Computer studies changed after the merger. This current development calls for a re-examination of how well the teaching and learning of the subject is executed.

The objectives of Computer Studies at the secondary school level of education according to Federal Ministry of Education (FME, 2007) is to enable the learner to: acquire basic computer skills such as the use of the keyboard, mouse and system, use the computer to facilitate learning electronically; develop reasonable level of competence on ICT applications that will engender entrepreneurial skills. Realising the objectives of computer studies as stipulated in the curriculum requires appropriate teaching methods, techniques, approaches and strategies. School subjects differ in content and difficulty level at which students learn them. One teaching method may not be suitable for learning all the subjects in school, consequently

the need to explore the effects of some teaching methods on the academic achievement of students. The teacher-centred technique which still goes on in schools seems to make teaching/learning of Computer studies clumsy, uninteresting and ineffective and hence very difficult to achieve its objectives in students' academic achievement in computer studies. There is need to search for appropriate teaching methods that will meaningfully supplement the conventional method already in use.

Despite the huge material and human resources employed in developing the new curriculum, it does appear that teachers are still employing more of traditional (conventional) teaching methods in their classroom instructions notwithstanding the fact that the present curriculum in use is activity based. Probably, the reasons for using traditional teaching method in schools might be primarily due to the fact that it was the same process the teachers were trained during their training days. Most teachers, who have the interest of implementing the curriculum as designed, are hindered by some challenges which may include: lack of requisite instructional materials, lack of training on how to use and practice some of the stated teacher activities, poor motivation, overload and large class size.

However, traditional teaching method according to Zvavanh (2010) can be described as the old school method of teaching which is teacher centred. Under conventional teaching method students are regarded as having "knowledge hole" that needed to be filled with information. Leaving this method for another teaching method means that, the new teaching method must be more effective in achieving the desired results. Several educators have outlined methods of teaching (Izuagba 2017). Some of the methods mentioned include: lecture method, problem solving method, discovery method, project method, individualized method and collaborative method. The choice of any of these methods in teaching depends on the age, content availability of resources, previous knowledge and teacher's versatility (Alamina 2008).

Thus, the cognitive, affective and psychomotor domains of the students can be developed and improved through collaborative teaching.

Collaborative learning according to some scholars is concerned with constructing meaning through interactions with others. It is an effective teaching and learning strategy for encouraging the sharing of ideas and discussions (Woolfolk, Hughes & Walkup, 2008). It is a learning strategy which involves groups of learners working together to solve a problem, complete a task, or create product (Izuagba, 2017). National Association for Language Development in the Curriculum (NALDIC) (2006) also found that group work stimulate dialogue and support the development of language skills. Using this approach in learning requires students to be active participant in the learning process in which they assimilate information and relate the new knowledge to their cognitive structure for future utilization and subsequent task.

Computer studies like every other science subjects, requires the use of appropriate teaching method if the stated objectives are to be achieved. Most computer studies students learn at different pace while the researcher has observed that some of the students learn easily from some of their peer/classmates. Based on these observations the researcher decided to investigate the effects of collaborative instruction on secondary schools students' achievement in computer studies in Imo State.

Purpose of the Study:

The purpose of the study was to determine the effects of collaborative instruction on secondary school students' achievement in computer studies. Specifically, the study determined the:

1. The differences between the mean achievement scores of students taught computer studies using collaborative instruction and those taught using the conventional method.

2. The differences between the mean achievement scores of male and female students taught computer studies using collaborative instructional methods.

Research Questions

In order to achieve the specific purposes of the study, the following research questions guided the study:

1. What is the difference between the mean achievement scores of students taught computer studies using collaborative instructional method and those taught using the conventional method?
2. What is the difference between the mean achievement scores of male and female students taught computer studies using collaborative instructional methods?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between the mean achievement scores of students taught computer studies using collaborative instructional method and those taught with conventional method.
2. There is no significant difference between the post-test mean achievement scores of male and female student taught computer studies using collaborative instructional methods?

Method

The study adopted quasi-experiment specifically, pre-test/post-test non-equivalent control group research design in which student exit in intact classes. Treatments with the use of collaborative method were administered to the experimental group and the conventional method for the control group.

The population of the study was made up of 1,647 JS3 students in the 14 public co-educational secondary schools in Mbaitoli L. G. A. The sample comprised 80 Junior Secondary Year Three (JS3) Computer studies Students. Two co-educational secondary schools were randomly drawn by paper balloting from the fourteen co-educational secondary schools in Mbaitoli Local Government Area. The two schools picked were categorised with the flip of a coin into experimental group one and control group. For each of the two drawn schools, one intact class of 40 JS3 Computer studies Students was randomly selected, making a total of two intact classes of 80 JS3 computer studies students from the two co-educational schools which were selected

The researcher designed Computer Achievement Test (CAT) to guide the study. It was subjected to face and content validity by two experts in Computer studies at Alvan Ikoku Federal College of Education Owerri, one lecturer in Science Education Department and one expert in Educational Measurement and Evaluation from Nnamdi Azikiwe University Awka. The instrument was administered before and after the treatment were applied to obtain the pre-test and post-test scores of the students on their computer performance. The CAT contained 20 items with four options drawn from computer Virus, Antivirus, spreadsheet packages and Search Engine to be taught to the students. The test items in CAT which has 20 items in number were answered within 45 minutes and had total scores of 100. Each question has four answer options and each correctly answered question attracts 5 marks, while each incorrect answer is zero. Kuder Richardson formular 20 was used to determine the coefficient as 0.82

Data for the study were collected through pre-test and post test scores using CAT. The pre-test was administered to the students before the treatment to provide the researcher with baseline data about the subject while post test (reshuffled CAT) was administered to the

students after the treatment to determine the students' actual achievement on computer studies. Data collected from the two tests (pre and post) after treatments were used for data analysis**.**

The administered CAT was collected and the sum of each of the students' score on CAT was determined. The mean and percentage scores of the pre-test and post-test scores for each of the two groups were obtained, mean and standard deviation were used to analyse data related to the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 significant level.

Results

The results of the study are presented in line with the research questions and hypotheses

Research Question 1:

What is the difference between the mean achievement scores of students taught computer studies using collaborative instructional method and those taught using the conventional method?

Table 1: Pre-test and post-test mean achievement scores of students taught computer studies with collaborative and conventional methods.

Instruction	N	pre-test mean	post-test mean	gained mean	pre-test SD	post-test SD	Remark
Collaborative	40	31.00	72.63	41.63	9.28	10.56	Effective
Conventional	40	24.13	47.38	23.25	6.00	7.34	

Table 1 shows that the students taught computer studies using collaborative method have a pre-test mean score of 31.00 and a post-test mean score of 72.63 with gained mean 41.63, while students taught using conventional method (control) have a pre-test mean score of 24.13 and post-test mean score of 47.38 with gained mean 23.25. With gained mean of 41.63, it shows that collaborative teaching method enhances achievement in computer studies than the conventional method. Table 1 shows from the standard deviation scores that the spread of scores increased in both from pre-test to post-test with collaborative learning group having the

highest standard deviation. With post-test mean score of 72.63 which is above 60% for collaborative instruction as against that of 47.38 for control group, collaborative instruction is effective in enhancing students' achievement in computer studies.

Research Question 2:

What is the difference between the mean achievement scores of male and female student taught computer studies using collaborative instructional methods?

Table 2: Differences in performances of male and female students taught computer studies using collaborative instructional methods

Instruction	Gender	N	pre-test	post-test	gained	pre-test post-test
			mean	mean	SD	SD
Collaborative	male	19	31.84	74.21	42.37	9.89 11.70
Instruction	female	21	30.24	71.19	40.95	8.87 9.47

Table 2 also shows that male students taught computer studies using collaborative instruction have a pre-test mean score of 31.84 and post-test mean score of 74.21 with gained mean 42.37, while the female students taught computer studies using collaborative have a pre-test mean score of 30.24 and post-test mean score of 71.19, with gained mean 40.95. With gained mean 42.37, it shows that male students performed better than female students in collaborative instructional method.

Hypothesis 1

There is no significant difference in post-test mean achievement scores of students taught computer studies using collaborative teaching method and those taught with conventional teaching method.

Table 3: ANCOVA on the differences in the post-test mean achievement scores of students taught computer studies using collaborative teaching method and those taught with conventional teaching method

Source of variation	SS	df	MS	Cal. F	P-value	P ≤ 0.05
Corrected Model	15080.981	2	7540.491			
Intercept	9617.447	1	9617.447			
Pre-test	2329.731	1	2329.731			
Group	6968.256	1	6968.256	130.26	0.000	S
Error	4119.019	77	53.494			
Total	307200.000	80				
Corrected Total	19200.000	79				

Table 3 indicates that at 0.05 level of significance, 1df numerator and 79df denominator, the calculated F is 130.26 with P-value of 0.000 which is less than 0.05. Therefore, the second null hypothesis is rejected. So, there is significant difference in post-test mean achievement scores of students taught computer studies using collaborative teaching method and those taught with conventional teaching method.

Hypothesis 2

There is no significant difference in post-test mean achievement scores of male and female students taught computer studies using collaborative teaching method.

Table 4: ANCOVA on the differences in the post-test mean achievement scores of male and female students taught computer studies using collaborative teaching method

Source of variation	SS	df	MS	Cal. F	P-value	P ≤ 0.05
Corrected Model	2074.443	2	1037.221			
Intercept	7571.289	1	7571.289			
Pre-test	1983.464	1	1983.464			
Gender	31.466	1	31.466	0.512	0.479	NS
Error	2274.932	37	61.485			
Total	215325.000	40				
Corrected Total	4349.375	39				

Table 4 indicates that at 0.05 level of significance, 1df numerator and 39df denominator, the calculated F is 0.512 with P-value of 0.479which is greater than 0.05. Therefore, the second null hypothesis is not rejected. So, there is no significant difference in post-test mean achievement scores of male and female students taught computer studies using collaborative teaching method.

Discussion of Findings

The findings of the study showed that students taught using collaborative teaching method performed higher than those taught using conventional group in the achievement tests as shown by the mean gain. It shows that collaborative teaching method significantly enhanced students' achievement in computer studies more than the conventional method. This improvement in the achievement of computer studies students through the use of collaborative instruction can be explained from the fact that collaborative instruction increased personal, social and intellectual development, academic attainment and positive interaction among students. Collaborative instruction engage students in group and thereby increase learning, education, knowledge and skills (Brown & Ciuffetelli, 2009) The findings of this study support the findings of the previous researchers (Offiah & Okonkwo, 2011) that affirmed that cooperative learning strategy facilitate students' achievement in chemistry than the conventional teaching method. Ogbuefi (2006) held that many students have shown that two or more individuals can solve problems of different kinds better, when they work in groups than when they work independently. It also agrees with the studies of Ogbaji (2003) who reported that cooperative learning interaction strategy is more effective in enhancing students' academic achievement in biology than the conventional method. It is also supported by Odumodu (2016) who reported that there was a significance difference in the proportion of students taught in cooperative classroom goal structure whose locus of control changed from

external to internal locus when compared with those taught in a competitive classroom goal structure.

More so, the findings in this study revealed that gender is not a significant factor in students' achievement in computer studies. This finding of the study is supported by the findings of Awofola and Nneji (2013) who reported that there was no significant difference between mathematics achievement of male and female students taught with team assisted individualized instructional approach. The finding of this study is also supported by the findings of Izuegbunam (2018) who reported that there was no significant difference in the mean achievement scores of male and female students' achievement in chemistry both in the cooperative learning and individualized instruction

Conclusion

Collaborative teaching method significantly enhanced students' achievement in computer studies more than the conventional method and also gender is not a significant factor in students' achievement in computer studies. Therefore, this study lends empirical support to the fact that students' academic achievement in computer studies could be greatly improved when the teacher exposes the students to innovative, student-centred and activity-based instructional methods such as collaborative instructional method.

Recommendations

The following recommendations are made based on the findings:

1. Teachers should adopt collaborative teaching method since it enhanced students' achievement in computer studies. It will enable students develop more knowledge and skill in computer.

2. Teachers' training institutions should ensure that student teachers are adequately exposed to collaborative teaching method so that they should effectively and efficiently employ them when they graduate and use them in the field of teaching.
3. Ministry of education and policy makers in education should organize seminars, workshops and conference in order to train and retrain the teachers already in the field and to create awareness about this teaching method so as to adopt them in their teaching.

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Effect of Laboratory Technique on Secondary School Chemistry Students' Acquisition of Production Skills in Liquid Soap Making in Imo State, Nigeria

Uwaleke, C. C.
Department of Science Education, Alex Ekwueme Federal University Ndufu-Alike Ikwo, Ebonyi State, Nigeria
chidebe.uwaleke@funai.edu.ng

&

Okoli, J. N.
Department of Science Education, Nnamdi Azikiwe University Awka, Anambra State, Nigeria.
jn.okoli@unizik.edu.ng

Abstract

This study determined the effect of laboratory technique on secondary school chemistry students' acquisition of production skills in liquid soap making in Okigwe Education Zone of Imo State, Nigeria. Two research questions and one null hypothesis guided the study. Quasi experimental research design was adopted for the study with a sample of 98 senior secondary two (SSII) chemistry students' selected from two out of 40 governments secondary schools in the zone. Liquid Soap Production Skills Rating Scale (LSPS_RS) was the instrument used for data collection. The LSPS_RS was validated by four experts (two from chemistry education and two from educational measurement and evaluation) and Cronbach alpha reliability coefficient of 0.81 was established. Treatment in the two groups lasted for four weeks. Data were analysed using mean, standard deviation and Analysis of Covariance. The findings revealed that students who were exposed to laboratory technique acquired higher production skills in liquid soap making than those taught using the conventional technique. It was concluded therefore that the use of laboratory technique enhanced students' acquisition of production skills in liquid soap making. Based on the findings, it was recommended among others that teachers should expose their students to liquid soap making using the laboratory technique in order to develop production skills that will make them self-reliant and employer of labour.

***Key words*:** laboratory technique, production skills, liquid soap, secondary school, chemistry

Introduction

Chemistry is a core science subject taught in Secondary Schools in Nigeria and its teaching and learning involves much of practical and laboratory activities. The practical activities carried out by secondary school chemistry students in the laboratory provide the foundation for technological development and prepares them for the pursuit of science related courses at higher levels. The teaching and learning of chemistry at secondary school level in Nigeria is expected to produce individuals/students that are capable of being self-employed

and employers of labour. Such individuals are expected to be independent, confident and self-reliant and also have great passion for chemistry, but today the reverse in the case. Since Chemistry is a science subject based on experimentation, students' active involvement in the subject needs to be encouraged by teaching it through activity-based approach (Alaribe 2010; Odesina, 2008). These activities include, touching, seeing, feeling, weighing, measuring, demonstrating, carrying out tests/experiments and any other practical activities in the laboratory (Terwase, et al 2019).

Chemistry teachers in secondary schools have been teaching chemistry using conventional techniques such as lecture method, expository, discussion and demonstration to ensure that the subject is well taught and comprehended by their students. Despite the application of these techniques, students have not really been performing up to expectations (Omiko 2015; Okeke 2014). This could be because conventional techniques do not really give students the opportunity to participate actively during teaching and learning, hence they become passive listener during lessons which at the end makes the students see the subject as an abstract and uninteresting subject (Ogunbiyi, 2019). Various research had been undertaken to investigate trends in students' achievement in chemistry and the factors influencing chemistry learning. Unfortunately, successive efforts to improve the teaching and learning of chemistry have not yielded sufficient improvement in students' performance in the subject (Babafemi, 2016; Odutuyi, 2015). This could be attributed to none acquisition of required skills in laboratory work by the students.

WAEC Chief Examiner's Report (2018), suggested that students' skills acquisition and achievement in chemistry could be improved through meaningful and proper teaching techniques which can be related to real life situations. According to the report, teachers should help students acquire skills in chemistry by reducing the rate of teaching the subject

theoretically. It therefore becomes imperative to look for interventions that could be put in place to improve learning outcomes.

Across Nigeria, with particular reference to Imo State and Okigwe Education zone specifically; great emphasis is being placed on industrial, technological development and advancement (Uwaleke and Offiah, 2013). Studies conducted by researchers like, Omiko (2015) and Okigbo and Osuafor (2008) has shown that some relationship exists between students' acquisition of skills when different technique are used, although their studies were in biology and mathematics. The researcher is not aware of any current attention directed towards ascertaining the effect of laboratory technique on students' acquisition of production skills especially at the secondary school level and Okigwe Education zone of Imo state, Nigeria.

Production skill can be defined as the process employed to transform tangible inputs (raw materials) and intangible input (ideas, information and knowledge) into goods. Okeke (2015) identified the following as some of the attributes/qualities one should possess for producing good/quality products: knowing what to produce, that is the definition of what you want/intend to produce; knowing the material to be used for/in the production; being able to know the accurate volume, quantity or measurement of the recipes/materials to be used for/in the production process and knowing the right steps to follow in order to have a quality product at the end of your production.

Production skill in liquid soap making is therefore the expertise to produce liquid soap or transform raw materials into liquid soap, which can be in small or large quantities. This implies that science teachers and chemistry teachers in particular need to acquire the skills for effective teaching and learning to take place especially during practicals (Okenyi, Olehi & Njoku, 2010). The researcher believes that when students acquire production skills like the

ones needed in the production of liquid soap, bleach, ice cream, paint, shoe polish among others from their knowledge of Chemistry in secondary school, they will become self-reliant after graduation. This corroborate Eze (2010); Njelita, Egolum, and Ezeokeke (2014) that if students are taught the production of simple consumable goods like matches, candles, liquid soap, ice cream, detergents and soaps through environmental and industrial chemistry, they can acquire self-reliant skills to create jobs for themselves and for others when they graduate. It is assumed that if chemistry students in secondary schools in Nigeria and Okigwe Education zone of Imo State precisely, can effectively acquire production skills in liquid soap making before completing their secondary education, they will become self-reliant later in life, which can result in improve academic performance in the subject.

This study is based on Bruner's (1966) constructivist theory of learning which states that learning is an active process in which learners construct/acquire new knowledge/ideas based upon the current or past knowledge. Bruner's theory on discovery learning is an approach where the learner discovers or produces things for himself/herself. Bruner's theory suggests that children must be motivated and challenged to learn, but this should be within their level of maturational readiness and cognitive abilities. However, the awareness of these cognitive developments by the chemistry teacher and a conversion of the awareness into teaching especially in the chemistry laboratory will be a great challenge to the learner. The laboratory and the conventional techniques of teaching chemistry will serve as a motivator and challenge to chemistry students. Hence, Brunner's constructive learning theory provides the theoretical base for this study which sought to determine how the use of laboratory techniques affects SSII chemistry students' acquisition of production skills in liquid soap making.

Evidence from studies in Nigeria shows that exposure to laboratory apparatus activities on acquisition of process skills is effective in enhancing students' science process skills and

academic performance on difficult concepts (Babafemi, 2016). It was also found that laboratory-based instructional intervention on the learning outcomes of low performing senior secondary students in Physics, Mathematics and Automobile Electric Works yields better performances of SSII students than exposure to conventional technique (Ogunbiyi et al. 2019; Terwase et al. 2019). Although these studies are related to the present study in terms of exposure to laboratory activities but they are different in terms of location, sample and design.

Purpose of the Study

The purpose of this study was to determine the effect of laboratory technique on secondary school students' acquisition of production skills in liquid soap making. Specifically the study sought to determine the difference in mean production skill acquisition scores of secondary school chemistry students taught liquid soap making using laboratory method and those taught using conventional method.

Research Questions

The following research questions were formulated to guide this study:

1. What is the difference between the mean production skill acquisition scores of secondary school chemistry students taught liquid soap making using laboratory method and those taught using conventional method?
2. What is the level of production skills acquisition in liquid soap making by secondary school chemistry students when taught with laboratory and conventional techniques using their pre-test post-test scores?

Hypothesis

The following hypothesis was formulated and tested at 0.05 level of significance.

1. There is no significance difference in the post-test mean production skills scores of SSII chemistry students exposed to laboratory technique and those exposed to conventional technique after controlling for pre-test.

Method

The study adopted a quasi-experimental research design which was focused on Senior Secondary School (SSII) chemistry students from Government owned secondary schools in Okigwe Education Zone II in Imo state, Nigeria. It was aimed at determining the effect of laboratory technique on SSII chemistry students' acquisition of production skills in liquid soap making. Population of the study comprised all the 1,766 SSII students in the 40 government owned secondary schools in the zone. A sample of 98 SS II chemistry students from two schools was randomly selected from the 40 government-owned secondary schools in the zone. The Liquid Soap Production Skills-Rating Scale (LSPS_RS) was the instrument used for data collection which was validated by experts from chemistry education and educational measurement and evaluation.

The LSPS_RS was designed to measure the extent to which students acquired production skills in liquid soap making. The scale consists of two sections A and B. Section A sought information on each student's school and sex, as well as date of the rating; while section B sought information on liquid soap making. It was assumed that any chemistry student who acquires production skills of liquid soap making should be able to identify the materials needed for the production of liquid soap, know the procedure to adopt, observe and reason from specific to more general principle in the specific process, as well as possess the ability to measure accurately the required quantity of materials needed for the production of liquid soap.

Section B also has to do with rating the extent to which each student acquires the production skills in liquid soap compared with students you know, using the following 4-point rating scale. Significantly Less Able (SGLA) = 1, Slightly Less Able (SLLA) = 2, Slightly More Able (SLMA) = 3, Significantly More Able (SGMA) = 4

Since liquid soap production involves seventeen (17) procedures/processes which yield a total acceptable score of 2.50 x 17 = 42.50. Therefore, in interpreting data for research questions 42.50 and above was used as benchmark to determine the effect of laboratory technique on students' acquisition of production skills in liquid soap making. The reliability of the LSPS_RS was established using Cronbach alpha method with a sample of 32 students from Owerri zone which is outside the study area. The reliability co-efficient was 0.81 which is considered high and acceptable for the study.

Before the commencement of the experiment, the two schools chosen for this study were assigned to experimental and control groups by simple flip of a coin. Prior to the experiment, students in the two sampled groups were taken to the chemistry laboratory and the raw materials needed for the production of liquid soap were displayed on the laboratory benches and students were asked to use the materials to make liquid soap and as they are doing it, the researcher along with the chemistry teachers who were adequately trained rated them using the LSPS_RS. This served as the pre-test and no feedback on the pre-test was given to them.

Data collection started after all the 98 randomly selected SSII chemistry students from the two schools have been taught how to make liquid soap. The following materials were used for liquid soap production: Nitrosol, sodium laurel sulphate, sodium carbonate, sodium ethasulphate, sodium hydroxide, sodium benzoate or ethanol, sulphonic acid, perfume and colour. This could be called the recipes or raw materials used in liquid soap production. As

their regular chemistry teacher along with the researcher was teaching them practically how to make liquid soap, students learnt and produced theirs as well because all the recipes/materials needed for the production were made available by the researcher and were placed on their benches. The teachers made use of the lesson plan prepared for the experimental group to serve as guide during the production process. The teaching took place in students' chemistry laboratory at the time of their normal lesson. Students were properly exposed on how to produce liquid soap.

Also the chemistry teacher with the guidance of the researcher taught the control group the same topic: liquid soap production. The control group was also exposed to how to make liquid soap with the conventional lecture technique. The time for their normal lesson was used in conducting this study and the teaching also took place in their chemistry laboratory. The reason for using the chemistry laboratory to teach the control group was for them to be exposed to the same learning environment as the experimental group.

At the end of the four weeks teaching exercise all the students in the two intact classes (experimental and control groups) were rated on acquisition of production skills in liquid soap making using the LSPS_RS immediately after the treatment. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the null hypothesis at 0.05 levels of significance. The results of data analysis are presented in Tables 1 and 2.

Results

What is the difference between the mean production skill acquisition scores of secondary school chemistry students taught liquid soap making using laboratory method and those taught using conventional method?

What is the level of production skills acquisition in liquid soap making by secondary school chemistry students when taught with laboratory and conventional techniques using their pre-test post-test scores?

Table 1: *Mean and Standard Deviation of the Production Skills Acquisition Scores of Students' taught Liquid Soap Making using Laboratory and Conventional Techniques*

Teaching Technique	N	Pre-test Mean	Post-test Mean	Pre-test SD	Post-test SD	Mean Gain
Laboratory Technique	50	30.46	53.36	7.55	3.57	22.90
Conventional Technique	48	28.96	43.20	3.04	4.36	14.24

Table 1 shows that students that were exposed to laboratory techniques had a pre-test mean score of 30.46 with a standard deviation of 7.55, while the post-test mean score was 53.36 and standard deviation of 3.57. The mean gain score between the pre-test and the post-test for the experimental group was 22.90. The standard deviation of 7.55 at pre-test and 3.57 at post-test for the experimental group shows that as the group mean score increases, the variability of the scores also increases slightly. The students taught liquid soap making using the conventional technique had a pre-test mean score of 28.96 and a standard deviation of 3.04 and a post-test mean score of 43.20 and a standard deviation of 4.36. The mean gain scores of the experimental and control groups are 22.90 and 14.24 respectively. This implies that the students exposed to laboratory technique, acquired more production skills in liquid soap making than those in the control group. The post-test mean score of 53.36 as against the benchmark of 42.5 suggests that laboratory technique is effective in enhancing production skills acquisition in liquid soap making.

Result in Table 1 also reveals that with post-test mean score of 53.36 as against the benchmark of 42.5, student's acquisition of production skills in liquid soap making increased in level. Also the post-test means scores in both groups is higher than the pre-tests in the two approaches (pre-test 30.46 - post-test 53.36) and (pre-test 28.96 – post-test 43.20) respectively.

Table 2: *Summary of One-way Analysis of Covariance (ANCOVA) Test of Significant Difference between Students Overall Production Skills Acquisition Scores in Liquid Soap Making Using Laboratory and Conventional Techniques*

Source	Type III Sum of Squares	Df	Mean Square	F	P-value
Corrected Model	2524.256[a]	2	1262.128	85.097	.000
Intercept	8094.510	1	8094.510	545.758	.000
Pre-test	.428	1	.428	.029	.866
Method	2472.882	1	2472.882	166.730	.000
Error	1409.009	95	14.832		
Total	233388.000	98			
Corrected Total	3933.265	97			

Table 2 shows a one-way ANCOVA which was conducted to compare the effectiveness of teaching liquid soap making (laboratory technique and conventional technique) while controlling for pre-test effect. The Table shows that there was a significant difference in the mean post-test scores [F(1, 95) = 166.730, p = .000]. This means that the observed difference in mean post-test production skills of the students taught with laboratory technique and conventional technique as shown in Table was significant and cannot be attributed to error associate with the study.

Discussion

The finding of this study shows that there is a significant difference between the mean production skills acquisition scores of chemistry students taught liquid soap making using the laboratory and conventional techniques in favour of laboratory group. Students' level of acquisition of production skills in liquid soap making increased when exposed to laboratory and conventional techniques as can be seen in their respective pre-test and post-test mean scores.

The findings of this study is consistent with findings of Okeke (2015), Udosen (2015) and Babafemi (2016) that students exposed to laboratory technique acquires more production

skills than those exposed to the convention method. The results of this study also corroborates the findings of Katcha and Wushishi (2015) and Onwukwe (2011) which revealed that the use of the laboratory method helps chemistry students to develop scientific skills for practical's and problem solving more than the conventional approach. It agrees with Eze (2010), Omosewo (2014), Ojirindan, Oludipe & Ehindero (2014) and Terwase et al. (2019), who calls for a shift from the conventional lecture technique of teaching to innovative teaching techniques in teaching Science and Technology for effectiveness. The finding may be attributed to the fact that laboratory technique is based on the principles of learning by doing, learning by observation, and proceeding from concrete to abstract. The implication is that laboratory technique should be used as a more effective technique of enhancing students' acquisition of production skills in liquid soap making and other products than the conventional lecture technique. Using laboratory technique can enhance the development of entrepreneurial skills needed for making chemistry students self-reliant and employers of labour.

Conclusion

Based on the findings of the study, it was concluded that laboratory technique was effective in enhancing secondary school students' acquisition of production skills in liquid soap making.

Recommendations

1. Students should be exposed by their teachers to the use of laboratory technique since the findings have indicated that laboratory technique enhances the acquisition of production skills in liquid soap making.
2. Teachers should endeavor to identify the level of acquisition of production skills by students. Teachers should therefor put in place well-planned instructional strategies that

will help students develop high level production skills which will enhance their achievement in chemistry and life generally.

3. The professional bodies like Science Teachers Association of Nigeria (STAN) and Curriculum Organization of Nigeria, (CON) should endeavour to implement more policies in Education which would involve practical programmes in secondary schools. This will encourage the involvement of both the students and their teachers in the proper use and application of production skills in making different products in all the science subjects, especially challenging subjects like chemistry.

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