EFFECTS OF 5E INSTRUCTIONAL MODEL ON PUPILS WITH VISUAL IMPAIRMENT ACHIEVEMENT IN BASIC SCIENCE AND TECHNOLOGY IN JABI ABUJA, NIGERIA

BY

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ABSTRACT

This study examined the effects of 5E instructional model on pupils with visual impairment achievement in Basic Science and Technology. The sample of the study comprised of 10 male and 6 female pupils with visual impairment in FCT School for the Blind Jabi, Abuja, Nigeria. The study adopted quasi experimental research design. An Optometrist Assessment Report was developed after the screening to categorize the pupils based on degree of visual impairment that is, total blindness and low vision also on the onset of visual impairment that is, congenital and adventitious. The Basic Science and Technology Achievement Test was used for data collection. A reliability of internal consistency coefficient of 0.95 was obtained. Eight research questions and nine hypotheses were formulated for the study. Simple percentages graphs, means and standard deviation were used to answer the research questions. The t-test for independent samples and Analysis of Covariance (ANCOVA) were used to test the hypotheses at 0.05 level of significance. The major findings of the study revealed that there was a significant difference between the Basic Science and Technology achievement mean scores of pupils with visual impairment in the experimental and control groups. This implies that as a result of the intervention, pupils' achievement in Basic Science and Technology improved significantly as compared to pupils taught using the text-book approach.

Keyboards: 5E instructional model, Constructivism, Inquiry Based Model, Basic Science and Technology.

Introduction

Background to the Study

The education to pupils with visual impairment is an area that requires educational reformation in Nigeria. Pupils with visual impairment frequently miss out on lessons because teachers often lack the knowledge and skills to make appropriate accommodations for them. The Individuals with Disabilities Education Act (IDEA) (2013) defines visual impairment as vision loss which adversely affects a child's educational performance. Visual impairment is classified in degrees: a) total blindness: visual acuity worse or less than 20/200 including light perception and nil light perception in the better eye with the best corrected vision. b) low vision: visual acuity worse or less than 20/70 and 20/100 including light perception and nil light perception) in the better eye with the best corrected vision. The term is also classified based as onset or advent of visual impairment which includes; a) congenital impairment: this refers to vision loss that occurs from birth or immediately following birth and occurs before visual memory has been established while b) adventitious impairment: this refers to vision loss that is acquired after birth to adulthood and occurs after visual memory has been established. A survey by the World Health Organization/Eye Examination Record for Children with Blindness (WHO/ERCB) 2015 reveals that in Nigeria, 85% of children with eye disorders have total blindness and low vision. This implies that the more prevalent category of children with visual impairment in Nigerian schools include those with total blindness and low vision.

The Federal Ministry of Education (FME, 2013) stipulates in the National Policy on Education that Basic Science and Technology should be a core subject in the primary education curriculum which is aimed at laying a sound basis for acquisition of scientific, critical and reflective thinking skills among pupils in Nigerian primary schools. Basic Science is recognized as a fundamental subject in the education of all pupils including those with visual impairment. However, the process of inculcating these skills usually pose a great challenge to teachers as they often find it difficult to select and apply an appropriate instructional strategy for teaching Basic Science and Technology to pupils with visual impairment because most of these learning experiences require sight or non-concrete objects. This challenge is largely due to the fact that Basic Science and Technology involves experiments, field trips, exploration, observation, classifying, measurement, analysis, and arriving at logical conclusions which the use of sight becomes necessary.

Over the years, Science teaching has relied on methods that train pupils to follow directions with little connection to inquiry based teaching methods and pupils have become accustomed to this method of learning, most of which do not form a deep conceptual understanding of Basic Science and Technology (Nadelson, Williams & Turner, 2005). The most prominent among these methods is the text-book approach which is more challenging to pupils with visual impairment due to lack of vision to see diagrams and illustrations replete in text-books. Pupils are also unable to carry out experiments, measurements and observation which are core activities in explaining and describing concepts in Basic Science and Technology lessons.

Consequently, there is a total dissatisfaction on how science is still traditionally being taught to pupils with visual impairment (Yaksat & Hill, 1994). This dissatisfaction and its inherent challenges have led to a major shift towards inquiry-based practices in the teaching and learning of Basic Science and Technology. This major shift towards inquiry-based approaches in science has led to the development of the 5E instructional model. However, literature is replete with the 'E' learning circle models such as 3E, 4E, 5E, 6E, and 7E. This study is hinged on the 5E instructional model. The 5E model is an example of a structured inquiry learning circle approach developed in the mid 1980's by principal investigator Roger Bybee and his team members: Joseph Taylor, April Gardner, Pamela Scotter, Janet Powell, Anne Westbrook, and Nancy Landes. It was developed specifically for Science programmes and it is used in the Biological Science Curriculum Study (BSCS). The model is aimed at transforming the teaching and learning of science that is based on most recent research, ensures scientific accuracy, includes field test with diverse pupils (including pupils with visual impairment) in diverse settings and upholds the principle of universal design for learning amongst others (Bybee et al. 2006). Based on the above premise, the researcher intends to ascertain the effects of 5E instructional model on pupils with visual impairment achievement in Basic Science and Technology in Jabi, Abuja.

Statement of the Problem

The academic achievement of pupils with visual impairment in Basic Science and Technology has been considerably poor in some concepts that mostly involve observation, experiments, and measurements. Pupils' poor achievement has been backed with the erroneous notion that because the child has visual impairment, he/she cannot achieve in various educational tasks and educational activities (Dantata, 2015). Pupils with visual impairment often find it challenging understanding difficult science concepts. As a result, pupils with visual impairment often miss out on science lessons and find it difficult to understand certain Basic Science and Technology concepts. There is also poor utilization of inquiry-based methods such as 5E instructional approach in teaching science based subjects to pupils with visual impairment. It has been argued that Science opportunities for children with visual impairment are often restrictive, sometimes non-existent and has traditionally been a difficult subject for pupils with visual impairment because they are typically presented in visual formats (Obani, 2004; Omede & Tenimu, 2013; Sahin & Yorek, 2009) as characterized by the text book approach. . Therefore, there is need to bridge the gap between these shortfalls in incidental learning as well as learning by imitation which is typical of sighted pupils through the use of the 5E instructional model.

Aims and Objectives of the Study

The aim of this study was to investigate the effects of 5E instructional model on pupils with visual impairment achievement in Basic Science and Technology in Jabi, Abuja. Specifically, the objectives of this study were to: a) ascertain the pretest mean scores of pupils based on gender, degree and onset of visual impairment in experimental and control groups. b) ascertain the effects of 5E instructional model on achievement of pupils with adventitious visual congenital impairment in Basic Science and Technology. c) determine if

any difference exists between the pretest and posttest Basic Science and Technology achievement of male and female pupils with visual impairment exposed to 5E instructional model.

Research Questions

The following research questions were raised to guide the study: a) What is the pretest Basic Science and Technology achievement mean scores of pupils with total blindness and low vision in the experimental and control groups? b) What is the pretest Basic Science and Technology achievement mean scores of pupils with adventitious and congenital visual impairment in the experimental and control groups? c) What is the pretest Basic Science and Technology achievement mean scores of male and female pupils with visual impairment in the experimental and control groups? d) To what extent does the use of 5E Instructional model affect the Basic Science and Technology achievement of male and female pupils with visual impairment in the experimental and control groups?

Hypotheses

The following hypotheses were formulated to guide the study and tested at 0.05 level of significance: 1) There is no significant difference between the pretest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups. 2) There is no significant difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups. 3) There is no significant difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils with visual impairment in the experimental and control groups.

Significance of the Study

The findings of this study will hopefully be of benefit to pupils with visual impairment, parents and teachers of pupils with visual impairment, curriculum planners/developers and future researchers, Government and Non-Governmental Organization (NGOs). Due to its practical research significance, the findings of this study when completed would hopefully enable curriculum planners/developers, teachers of students with visual impairment as well as other stakeholders to see a need to, in the education of students with visual impairment, include procedures of learning circle inquiry-based model in the content, objective, organization of learning experiences and evaluation.

Theoretical Framework

This study is hinged on the cognitive constructivism theory propounded by Piaget (1896-1980). Piaget depicts an individuals' reaction to teaching and learning experiences that lead to/fail to promote learning and concluded that humans learn through the construction of progressively complex logical structures from infancy through adulthood. The constructivism theory is based on the premise of successive knowledge building that increases in depth and complexity from stage to stage. The constructivists' theory is based

on the idea that learners must individually discover and transform complex information if they are to make it on their own. Thus, this theory is appropriate for this study as 5E Instructional model which is an inquiry-based learning approach is closely linked to constructivist learning theories.

Review of Literature

As presented in the review of empirical studies, various research studies revealed that literature in science education teaching methods in internationally and also in Nigeria indicates that studies in learning circle methods are scarce and unavailable. The 5E Instructional Model as the name implies, constitutes five discrete elements such as: Engagement; Exploration; Explanation; Elaboration and Evaluation. Each phase of the model, according to the Biological Science Curriculum Study (BSCS, 2015) indicates its purpose from both teachers and pupils' perspectives to include: engagement (pupils prior knowledge accessed and interest engaged in the phenomenon); exploration (pupils participate in an activity that facilitates conceptual change); explanation (pupils generate an explanation of the phenomenon); elaboration (pupils understanding of the phenomenon is challenged and deepened through new experiences) and evaluation (pupils assess their understanding of the phenomenon). The exploration phase is very important for pupils with visual impairment as it gives them the opportunity to explore (examine) real objects or models of objects tactually while the elaboration phase gives them the opportunity to clear doubts or misconceptions that may arise after the exploration phase. The 5E instructional model helps to develop pupils' critical thinking skills, ensures adaptability, encourage complex communication, self-development and teamwork.

Inquiry based interventions in science teaching and learning is globally accepted and used in teaching science to pupils with visual impairment in Basic Science and Technology classrooms. It is a better alternative than the traditional or textbook approach that is commonly used. Findings from several studies (Yuen, Westwood & Wong, 2004; Ajaja 2013; Altun, Yalcin, Acisli and Turgut, 2010; Acisli, 2010) indicated that 5E Model is more effective than traditional methods on pupils' understanding and retention, increasing learning level and improving academic achievement of science concepts.

Research Design

The study adopted the quasi experimental design. More specifically, the pretest-posttest non-equivalent control group design. This design is most appropriate when there is difficulty in randomization due to the few number of available subjects (Jaikumar, 2014). In this design, the experimental and control groups were selected without randomization, that is, the subjects will be an intact group and a pretest will be given to the two groups.

Population and Sample

The population of this study comprised of all the primary four pupils with visual impairment in the FCT School for the Blind Jabi, Abuja. A total of 16 pupils comprising of ten males and six females were in primary four in the FCT School for the Blind Jabi. Out of this

number, a total number consisted of nine pupils with total blindness and seven pupils with low vision and also out of which ten had congenital and six pupils had adventitious visual impairment. The choice of the school was due to the fact that it is the only school in Abuja that has the required pupils with these categories (low vision and total blindness who are either congenital or adventitious) of visual impairment in primary four.

Sampling Technique

The stratified sampling technique was used for the study. This sampling technique is most appropriate for this study because it involved examining sub-groups within the population of pupils with visual impairment and also ensured that each subgroup was adequately represented. These sub-groups consisted of degree of visual impairment (total blindness and low vision), onset of visual impairment (congenital and adventitious) and also gender (male and female). Similarly, the Optometric Assessment Report (OAR) was used in categorizing pupils into those with total blindness and low vision as well as identifying those with congenital and adventitious visual impairment. The pupils were assigned into experimental and control groups through the use of simple random sampling (balloting system). Odd and even numbers from one to 16 were written on pieces of paper and, pupils picked the numbers at random. Pupils with total blindness and low vision (may have either adventitious or congenital blindness) who picked even numbers comprised the experimental group while pupils who picked odd numbers comprised the control group.

Procedure for Data Collection

Four research assistants were trained for one week prior to the commencement of the intervention. A training schedule and manual was developed to specify the contents of the training on the use of the 5E instructional model for instruction for research assistants. The primary four pupils were assigned into experimental and control groups respectively. The BSTAT was administered as pretest on the pupils. Thereafter the intervention (5E Instructional model) was given to the experimental group while the control group was taught using the text-book approach. After the intervention, the BSTAT was administered to both groups as posttest. The intervention was an 11 week instructional unit in Basic Science carried out to cover the following topics: forms of water, evaporation of water, parts and functions of the human heart, sources and uses of heat and measurement of length and volume for primary four pupils with visual impairment.

Method of Data Analysis

Research questions were answered using percentage, mean and standard deviation and presented in tables and bar charts. The hypotheses were analyzed using t-test for independent samples and Analysis of Covariance (ANCOVA) which is appropriate to ascertain if differences exist between and within groups.

Results and Discussion

Research Question One: What is the pretest Basic Science and Technology achievement mean scores of pupils with total blindness and low vision in the experimental and control groups?

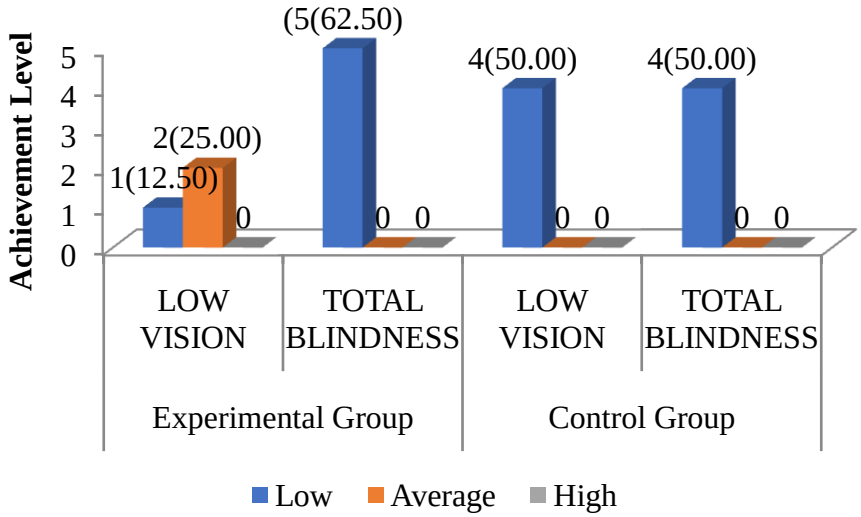

Figure 1: The Pretest Basic Science and Technology Achievement Mean Scores of Pupils with Total Blindness and Low Vision in the Experimental and Control Group

Figure 1 reveals the pretest Basic Science and Technology achievement mean scores of pupils with total blindness and low vision in Basic Science and Technology in the experimental and control groups. The table shows that pupils with total blindness had 5(62.50%) while pupils with low vision had 1(12.50%) and 2(25.00%) in the experimental group while pupils with total blindness had 4(50.00%) and pupils with low vision had 4(50.00%) in the control group indicating low and average achievement. However, none of the pupil had high achievement in Basic Science and Technology in the experimental and control group. This indicated that the overall achievement level of pupils with total blindness and low vision in Basic Science and Technology before intervention was considerably low for both experimental and control group.

Research Question Two: What is the pretest Basic Science and Technology achievement mean scores of pupils with congenital and adventitious visual impairment in the experimental and control groups?

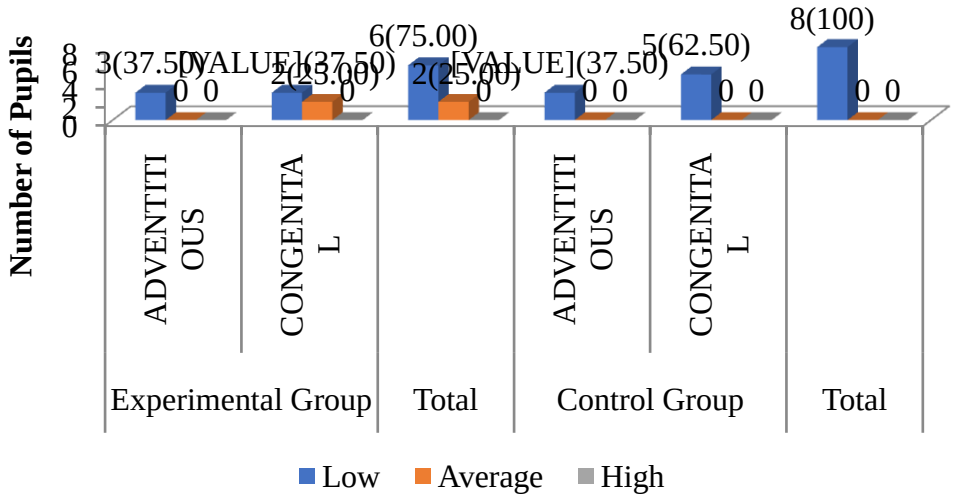

Figure 2: The Pretest Basic Science and Technology Achievement Mean Scores of Pupils with Congenital and Adventitious Visual Impairment in the Experimental and Control Group

Figure 2 reveals the pretest Basic Science and Technology achievement mean score of pupils with congenital and adventitious visual impairment in the experimental and control groups. The table shows that pupils with adventitious visual impairment had 3(37.50%) while congenital visual impairment had 3(37.50%) and 2(25.00%) in the experimental group. Pupils with adventitious visual impairment had 3(37.5%) while pupils with congenital visual impairment had 5(62.50%) in the control group. However, none of the pupils had high achievement in Basic Science and Technology in the experimental and control group. This indicated that the overall achievement level of pupils with congenital and adventitious visual impairment in Basic Science and Technology before intervention was considerably low for both experimental and control group.

Research Question Three: What is the pretest Basic Science and Technology achievement mean scores of male and female pupils with visual impairment in the experimental and control groups?

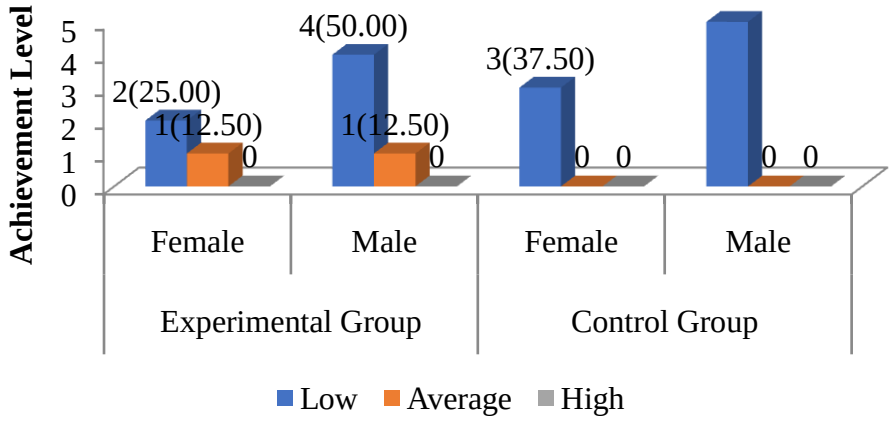

Figure 3: The Pretest Basic Science and Technology achievement Mean Scores of Male and Female Pupils with Visual Impairment in the Experimental and Control Group

Figure 3 reveals the pretest in Basic Science and Technology achievement mean scores of male and female pupils with visual impairment in the experimental and control groups. The results show that male pupils with visual impairment had 4(50.00%); 1(12.50%) and female pupils with visual impairment had 2(12.50%); 1(12.50%) in the experimental group while male pupils' visual impairment had 5(62.50%) and female pupils with visual impairment had 3(37.50%) in the control group. However, none had high achievement in Basic Science and Technology in the experimental and control group. This indicated that the overall achievement level of male and female pupils with visual impairment in Basic Science and Technology before intervention was considerably low for both experimental and control groups. This implies that the pretest Basic Science and Technology achievement of male and female pupils before intervention was considerably low.

Hypothesis One: There is no significant difference between the pretest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups.

Table 1

The ANCOVA Analysis for Difference between the Pretest Basic Science and Technology Achievement Test Mean Scores of Pupils Based on Gender, Degree and Onset of Visual Impairment in the Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1279.000[a]	11	116.273	.493	.840
Intercept	12695.664	1	12695.664	53.795	.002
Group	504.542	1	504.542	2.138	.218
gender2	42.471	1	42.471	.180	.693
Degree	185.143	1	185.143	.785	.426
ONSET	90.284	1	90.284	.383	.570
Error	944.000	4	236.000		
Total	18864.000	16			
Corrected Total	2223.000	15			

a. R Squared = .575 (Adjusted R Squared = -.592)

Table 1 revealed the Analysis of Covariance (ANCOVA) of pretest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual taught using 5E instructional model and those taught using text-book approach. Pupils with visual impairment taught with 5E instructional model had a mean score of 38.00, SD= 6.31 and pupils taught using text-book approach had a mean score of 26.50, SD=10.68. These Groups' results indicate that ($F(1, 16) = 2.138$, $P = 0.218$). The P-value 0.218 is greater than 0.05 level of significance. Therefore, there is no significant difference between the pretest Basic Science and Technology Achievement Test means scores of pupils based on gender,

degree and onset of visual impairment before exposure to 5E instructional model. Hence, the null hypothesis is upheld based on the results of the analysis from the data showing that there is no significant difference between the pretest Basic Science and Technology means scores of pupils based on gender, degree and onset of visual impairment. The results revealed the homogeneity of the groups, that is, the pupils are on the same ability level. Hence, any difference recorded subsequently will be due to the effect of the treatment.

Hypothesis Two: There is no significant difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups.

Table 2

The ANCOVA Analysis for Difference between the Posttest Basic Science and Technology Achievement Test Mean Scores of Pupils Based on Gender, Degree and Onset of Visual Impairment in the Experimental and Control Groups.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7279.750[a]	11	661.795	9.952	.020
Intercept	54975.619	1	54975.619	826.701	.000
GROUP	4817.932	1	4817.932	72.450	.001
GENDER2	188.235	1	188.235	2.831	.168
VISION	185.143	1	185.143	2.784	.171
ONSET	4.345	1	4.345	.065	.811
Error	266.000	4	66.500		
Total	76452.000	16			
Corrected Total	7545.750	15			

a. R Squared = .965 (Adjusted R Squared = .868)

Table 2 revealed the Analysis of Covariance (ANCOVA) for difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups. Pupils with visual impairment in the experimental group had a mean score 86.00, SD= 6.41 and pupils in the control group had a mean score of 45.25±9.38. The groups' results indicated that (F (1, 16) = 72.450, P = 0.001). The P-value 0.001 is less than 0.05 level of significance. Therefore, there is a significant difference between the posttest Basic Science and Technology means scores of pupils based on gender, degree and onset of visual impairment in the experimental and control groups The null hypothesis is rejected for the alternative hypothesis that a statistically significant difference exist between the posttest means scores of the two groups. This implies that pupils taught using 5E instructional model improved significantly irrespective of gender, degree and onset of visual impairment when compared to those taught using text-book approach. Hence, the 5E instructional model is an effective

strategy for improving the Basic Science and Technology achievement of pupils irrespective of gender, degree and onset of visual impairment.

Hypothesis Three: There is no significant difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils with visual in the experimental and control groups.

Table 3
The t-test Analysis for Difference between the posttest Basic Science and Technology Achievement Test Mean Scores of Pupils with Visual Impairment in the Experimental and Control Groups.

Groups	N	$\bar{X}$	SD	Df	t-cal	p-value
Experimental	8	86.00	6.41	14	10.145	.000
Control	8	45.25	9.38			

Table 3 revealed the t-test analysis for difference between the posttest Basic Science and Technology Achievement Test mean scores of pupils with visual impairment in the experimental and control groups. Pupils with visual impairment in experimental group had a mean score of 86.00, SD= 6.41 and pupils in the control group had a mean score of 45.25, SD = 9.38. This result indicates that (t (14) = 10.145, P = .000). The P-value 0.000 is less than 0.05 level of significance. Therefore, the null hypothesis that there is no significant difference between the posttest Basic Science and Technology Achievement Test means scores of pupils with visual impairment in the experimental and control group is not upheld based on the results of the analysis of the data gathered. Hence, the null hypothesis is rejected for the alternative hypothesis. Thus, we conclude that there is a significant difference between the Basic Science and Technology mean scores of pupils with visual impairment taught using 5E instructional model and those not taught using text-book approach. This implies that 5E instructional model helped in improving pupils' achievement in the Basic Science and Technology Achievement Test.

Discussion of Results

This finding agrees with the study by Erwin, Perkins, Fine and Rubin (2001) as well as Amaechi and Madu (2012) in a study on the impact of inquiry-based learning through 5E learning model for pupils with visual impairment. The study revealed that inquiry models has an impact on pupils' learning and knowledge of scientific concepts, active involvement, peer interaction, discussion, use of prior knowledge were essential in helping students understand science concepts and also enhanced pupils' understanding of key concepts in science. A study conducted by Rule (2011) concurs with the findings of this study which revealed a significant improvement in the frequency of science lessons, concrete nature of science lessons, enjoyment and excitement exhibited during lessons and active participation in lessons among students with visual impairment using 5E learning cycle model on teaching units of science.

The findings also showed that there is no significant difference between posttest Basic Science and Technology Achievement Test mean scores of male and female pupils with total blindness and low vision exposed to 5E instructional model. The findings is in line with the studies of Ajaja (2013); Altun, Yalcin, Acisli and Turgut (2010); Acisli, (2010); Acisli, Turgut, Yalcin, and Gurbuz (2009) and Newby (2004) which revealed that there is no significant difference between males and females on achievement in all methods used (5E instructional model, cooperative learning and lecture method). This study agrees with the findings of Kaynar, Takkaya and Cakiroglu (2009) as well as Suparsorn and Lordkam (2014) which showed a statistically significant mean difference between the experimental and control groups in favour of the experimental group after intervention using 5E instructional model. Similarly, the findings of this study was also in agreement with the studies of Yadigaroglu and Demircioglu (2013); findings revealed a statistically significant difference between the experimental (78.8) and the control (59.2) groups and 5E model was found to be more effective on pupils when compared to traditional text-book teaching.

Recommendations

Based on the findings of this study, the following recommendations are presented:

1. The study showed that 5E Instructional Model could be effective in curbing the poor achievement of pupils with visual impairment in Basic Science and Technology. Therefore, it is recommended that 5E Instructional Model in improving the academic performance of pupils with visual impairment in Basic Science and Technology as well as other Science subjects.
2. Nigerian Schools (Special and Inclusive) should adapt the use of 5E Instructional Model in the teaching of science related subjects. This is because teaching science involves experiments, exploration, observations, measurement etc. which involves the use of sight. Therefore, there is need to adapt a teaching model that will enable pupils with visual impairment benefit maximally in Science classrooms.
3. Teachers of pupils with visual impairment should give pupils with visual impairment the opportunity to explore their environment in order to actively participate in science classrooms. Therefore, the use of 5E Instructional Model which takes pupils through the five stages of learning (engage, explain, explore, elaborate and evaluate) should be adopted and implemented.
4. Teachers of pupils as well as students with visual impairment should be effectively trained on the knowledge, use and procedures of 5E Instructional Model for effective use in Science classrooms at all levels of education (elementary to tertiary).
5. More so, effective planning, reorganization and modification of the curriculum for pupils with visual impairment are necessary in order to accommodate learners with visual impairment. This will encourage flexibility in the adoption of 5E Instructional Models in providing meaningful learning experiences in teaching Basic Science and Technology in classrooms.

Conclusion

The findings of the study indicated that the use of 5E Instructional Model in teaching Basic Science and Technology to pupils with visual impairment will significantly curb the poor performance exhibited by pupils with visual impairment in Basic Science and Technology. Finally, the study showed that pupils with visual impairment who were exposed to 5E Instructional Model showed obvious positive improvement in the academic achievement of pupils with visual impairment in Basic Science and Technology. Therefore, 5E Instructional Model is an effective strategy in the education of pupils with visual impairment that will enable and help them fully access the curriculum and also benefit maximally from classroom instruction.

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