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# EFFECTS OF SENSORY STIMULATION TEACHING STRATEGY AND GENDER DISPARITY ON ACHIEVEMENT, RETENTION OF BASIC SCIENCE AND TECHNOLOGY STUDENTS IN NASARAWA STATE, NIGERIA

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## Abstract

The study investigated achievement, retention and gender effects of using sensory stimulation teaching strategy in Basic Science and Technology among students in Nasarawa State, Nigeria. The population comprised 3050 JSII students in 41 public co-educational junior secondary schools in Karu LGA of Nasarawa state made up of 1701 male students and 1349 female students for 2017/2018 session. A quasi-experimental pre-test, posttest, post posttest control group design was used. Through multi-stage random sampling, 2 intact and equivalent JSII classes were selected with sample size of 145. Using balloting, one of the classes was assigned as experimental group taught using sensory stimulation strategy and the other was the control group taught using conventional lecture method. The instrument used for data collection was Basic Science and Technology Achievement Test (BSTAT) made up of 40-item multiple choice questions and harmonized using a table of specification complying with modified Bloom's Educational taxonomy and validated by experts. The Reliability coefficient of BSTAT was 0.82 analyzed using Spearman Brown rank order correlation. Two lesson plans were also prepared and used for each instructional approach. Students in the experimental group were taught concepts in Basic Science and Technology using sensory stimulation strategy while students in the control group were taught using conventional lecture method. Four research questions were formulated with corresponding hypotheses. Data collected were analyzed using mean, standard deviation and ANCOVA statistics. The study revealed significantly higher achievement and better retention for students taught Basic Science and Technology concepts using sensory stimulation as against those taught using conventional lecture method. No significant effect was found in the interaction of gender on achievement and retention respectively. It is strongly recommended that teachers incorporate sensory stimulation teaching strategy in lesson delivery particularly when teaching Basic Science and Technology. Teachers should also vary their teaching strategies to eradicate gender-related difference in students' performance and eliminate sex-role stereotyping created by society on female students of science,

technology, engineering and mathematics related subjects.

**Keywords:** Sensory Stimulation, Achievement, Retention, Gender, Teaching strategy, Basic Science and Technology.

**Introduction**

Teaching is one of the oldest noble professions that play a pivotal role in actualizing the internationally recognized 4th Sustainable Development Goal to ensure quality education for all by 2030. This great goal cannot be achieved without effectiveness in the lesson/ instructional delivery approaches being adopted by teachers (UNESCO, 2019). Inclusive and equitable quality education and lifelong learning opportunities might become a reality for all pupils and students in basic education level if teachers can harness the potentials in these young learners by varying their teaching methods and strategies using modern and tested innovative teaching strategies. Young learners require scientific and technological knowledge and skills to help them develop innovative thinking, creativity as well as research ability (Okenjom, Ogar, Bake & Eze-Anyim, 2016). The present desire of developing nations to become less dependent on developed nations in area of science and technology will remain a mirage unless classroom theory and practice are radically transformed.

One of the greatest pitfalls of education in developing nations is that children do not develop effective and organized knowledge-based learning; hence, many fail to connect new information to existing knowledge structure (Adeyemo, 2012). This is partly because instruction has remained primarily didactic and dogmatic; teacher and textbook-centred leaving no room for such particular methods envisaged by the constructivist theories of learning science and technology. It is observed by Onah and Ike (2015) that in schools today, most teachers concentrate their efforts on the statement of instructional objectives in the cognitive domain while neglecting the affective and psychomotor domains. Lecture method involves a one-way directional movement of communication from teacher to learners (i.e. teacher–dominated), making students' passive listeners. This conventional method of teaching encourages memorization and rote learning of concepts without real exposure of students to the challenges that will make them be engaged actively in the learning process (Anyaegbunam, Nwodo & Enibe, 2015). The over reliance on these traditional methods may have tended to influence students' performance in subjects such as Basic Science and Technology.

Learning experiences that will appeal to the senses must be adequate and be conscientiously implemented to stimulate learners to process the necessary scientific and technological information for the development of cognitive, psychomotor and affective skills or competencies (Jin & Bierma, 2011). It is for this reason that the teaching of Basic Science and Technology might require the application of innovative teaching strategies such as sensory stimulation. Through appeal to all the senses of perception and emphasis on practical work, effectiveness of instruction could be improved upon. To further add credence to these suggestions, the basic education curriculum suggests using guided discovery

approach for teaching Basic Science and Technology. Constructivist theory generally suggests that meaningful learning must necessarily involve students in integrating new information or knowledge with pre-existing schemata. For practically based, meaningful and creative teaching and learning, use of sensory stimulation strategy might be considered as indispensable.

In Nigeria, for instance, the National Policy on Education, in its objective identified the acquisition of correct skills, abilities and competencies both psychological and physical as tools for the individual person to contribute his /her quota to the advancement of the society (Federal Republic of Nigeria, 2014). To implement these objectives, teaching and learning of Basic Science and Technology, of necessity need to be activity–based and child-centred. The teaching of Basic Science and Technology is by no means a simple task. Learning depends on the way materials are presented to learners and the way learners actively interact with the learning experiences presented. The new trend in Basic Science and Technology teaching has shown the need for a radical departure from the traditional lecture method to inquiry/discovery method, even to the recently proposed innovative teaching strategies such as sensory stimulation.

Sensory stimulation teaching-learning strategy has its basic premise from the sensory stimulation theory which stipulates that learning takes place and can be improved upon when more than visual and auditory senses are incorporated (MikeChin, 2011). The theory was propounded by Laird in 1985 (Dunn, 2002), an offshoot from the work of the German physicist, Hermann von Helmhotz, who was the first to work on sensory perception and inference (McGraw, Webb & Moore, 2008). When multiple senses are stimulated at the same time, learning can be enhanced. The senses can be stimulated through greater variety of colours, volume levels, strong statements, facts presented in visual form and the use of a variety of techniques and devices. It's a type of hands-on teaching-learning that gives learners more ways to connect new information with previous knowledge; understand and work through problems and inculcates non-verbal problem-solving skills in the learners (McGraw, Webb & Moore, 2008). Sensory stimulation refers to a variety of techniques applied to stimulate the senses with a view to increase alertness and reduce agitation (Gammeltoft, 2005). To Vozzella (2007) and Lykkeslet, Gjengedal, Skrondal and Storjord (2014), sensory stimulation involves the exploration of stimuli which includes visual, auditory, tactile, olfactory, kinesthetic and taste stimulation. The sensory integrative processes help people to interact effectively with the environment (Ayres, 1972). Research findings have proven that of the majority of knowledge held by adults, 75% is learned by process of seeing; hearing is next most effective accounting for about 13%, while the other senses (smell, taste and touch) account for 12% of what is known (Laird, 1985 in Dunn, 2002).

Information can easily be accessed, triggered and retrieved from students' cognitive learning centre. It is witnessed that when a child explores an object for the first time, repeated observation of the object from different angles is combined with co-ordinated tactile exploration with the use of hands

and sometimes the mouth. Such experience is used to build up congruent association between visual and tactile stimulation (McGraw, Webb & Moore, 2008). The use of multiple sense organs allows for more cognitive connections and associations with a concept (Pitts, 2012). All categories of learners can benefit from multisensory instruction including learners who do not have learning and attention problems (Morin & Wilson, 2015). When a student learns something with more than one sense perception, information or knowledge is likely to be impactful and lasting in memory. But multisensory learning is particularly helpful in teaching learners with learning and attention challenges. Educators and clinicians have for long period believed that multisensory training have capacity to improve learning. A simple benefit of multisensory teaching-learning according to Shams and Seitz (2015) is that it makes learning pleasurable to the learner and can engage individual with variegated learning styles, for example, while some people are 'visual learners'; others are 'auditory learners'.

'Achievement' is the past-oriented way of trying to measure the degree of attainment of success of an individual in an area or activity after adequate training has been carried out (Mangal, 2014). In this work, the achievement of students in concepts taken from Basic Science and Technology was determined after adequate teaching has been done for four weeks duration. The degree of academic performance of students or the measurable change in behaviour determined by the mean difference between post test scores and the pre test scores. Achievement tests are used to measure achievement in a learner. Achievement looks at the past and indicates what an individual has learned or acquired in a particular field. In measurement and evaluation, aptitude and achievement are both measures of ability (Anikweze, 2013). Aptitude denotes what a person has learned to do without requiring any training while achievement refers to what one has learned to do as a consequence of training.

Retention has to do with ability to preserve or keep up in the mind a learning experience for a period of time. The soundness or quality of one's memory can be judged on the basis of one's power of retention or retentively (Mangal, 2014). How properly one can store and retain the learned things or materials in one's memory storage, may provide a base for the measurement of the ability and capacity of one's memory. Retention can be measured by testing an individual's performance through reproduction or retrieval, i.e. in terms of recognition and recall. Retention in this study was measured based on the comparison of the mean of posttest score and the mean of post posttest score. In effect, retention indicates the extent to which the method or strategy of teaching has prevented forgetting by facilitating remembering.

Gender refers to the categorization of the research subjects into either male or female as a moderating factor in the experiment and with the assumption that students of different sexes may respond differentially to the use of the innovative teaching strategy being studied. Gender issue is treated as an essential factor in educational setting and capable of being an obstacle to high achievement of learners in Basic Science and Technology classes. Prominent among the factors identified by

Ugwu and Nzewi (2015) is sex-role stereotyping which seems to be the origin of differences between male and female participation and achievement in science and technology education. Lawani (2015) identified a manifestation of gender stereotyping in what she termed the "hidden curriculum" dealing with the unspoken or unwritten curriculum which sends out messages to girls to conform to role expectation. In her work, she counseled teachers to explore how gender dynamics affect their classrooms and be willing to change behaviour or patterns that affect girls negatively. The teacher has the responsibility to create an effective learning environment for all his or her students. It was hinted by Nworgu (2004) that there is an acknowledged problem of female under-achievement when compared with their male counterparts, apparently under equivalent conditions and this problem appear to be more pronounced in science, technology and Mathematics. It is also observed that language and illustrations used in some textbooks and instructional materials reflect gender bias. Boys are generally portrayed as intelligent, brave and adventurous, while girls on the other hand are shown as timid and shy, take care of homes, carry babies, sweep floors and perform one domestic activity or the other (Lawani, 2015). Some research works have shown contradictory evidences in students' academic achievement in sciences and technologies due to gender. It was observed by Usman in Uzoechi and Gimba (2015) that it is the female students that perform better than male students in learning activities that require manipulations. When gender-related differences occur in performance with science and technology subjects, the techniques, strategies and methods of teaching could be suspected (Uzoechi & Gimba, 2015).

Basic Science and Technology (BST) subject curriculum, presently in Nigeria is made up of subject-themes which include Basic Technology, Basic science, Information Technology/ Computer studies, Physical and Health Education (NERDC, 2012). The teaching-learning emphasizes skill development: entrepreneurial skills, creative thinking skills, and work skills. Since the curriculum provides the whole experiences to which all students and pupils must be enlightened on, the performance objectives, contents, activities for teachers and learners respectively, teaching-learning materials and evaluation guide are also made available (Igbokwe, 2015). Emovon in Otuka and Uzoechi (2014) viewed **science** as a body of knowledge that is acquired through observation and systematic experimentation. The systematic body of knowledge and concepts deal with cause and effects relationship. Technology, on the other hand is defined by Sowande, Adetomi, Aminu, Nlemadim and Thanni (2006) as a systematic way of doing things or solving practical problems for the good of mankind. One of the rationales behind the integration of science and technology curricula to get the present curriculum's structure is the necessity to inspire innovative teaching-learning techniques and approaches that enhance creativity and critical thinking in pupils and students (NERDC, 2012). The topics in each theme are sequentially arranged in spiral form advancing from simple to complex across the nine (9) years of basic education in order to arouse, sustain and maintain the interest of

learners, also to promote meaningful functional learning and skills development.

Furthermore, the Basic Science and Technology curriculum encourages guided inquiry and activity-centred teaching-learning with the use of materials that are locally sourced. In addition, the contents of the curriculum are fortified with real–life examples which are indigenous in nature and familiar to learners. These environmentally friendly examples engender the advancement of relevant qualities and survival strategies for successful living in contemporary and global world (Igbokwe, 2015). Basic Science and Technology Curriculum (revised 2012) offers contents and greater learning experiences which will engender the inculcation of functional, practical and relevant skills for job creation and wealth generation with the aim of reducing poverty within the communities and the nation at large. The activities are both learner-friendly and problem solving-centred, at the same time encouraging student-teacher, student-student interaction, group work or work-in pairs and learner interaction with resource materials.

**Statement of the Problem**

The persistent poor achievement of students in Basic Science and Technology at the Basic Education Certificate Examinations (BECE) and Junior Secondary School Certificate Examinations (JSSCE) being organized and conducted under the auspices of the Educational Resource Services (ERS) of Nasarawa State Ministry of Education and the National Examinations Council (NECO) respectively is of concern. Also the inability of graduating students at Basic education level to translate theory into practice in real life situation leaves stakeholders in doubt about the effectiveness of instructional delivery approaches. In addition, the influence of students' gender in their achievement in Basic Science and Technology has been of concern to education researchers for long. Yet, according to Ugwu and Nzewi (2015), no trend had emerged on the issue. In Nigeria, gender bias is still prevalent in science and technology education spheres; it has persisted even within the classroom setting. Agu and Edward (2015) pointed out that Nasarawa state as one of the States in the North Central geopolitical zone of Nigeria is often considered one of the educationally disadvantaged states especially in terms of female access to and aspiration in science and technology related subjects.

There is no evidence yet on whether comparing effect of use of sensory stimulation and conventional method is gender related regarding Basic Science and Technology subject. In view of this situation, there is need to investigate and find a solution to the performance of students especially at the Basic Education level, hence the need for this research. Use of proven innovative teaching strategies can trigger performance driven potentials inherent in the pupils or students. The problem of this study, therefore was to determine the effects of sensory stimulation teaching strategy and gender disparity on achievement, retention of Basic Science and Technology students in Nasarawa State, Nigeria

**Purpose of the Study**

The purpose of this study was to find out the effects of sensory stimulation teaching strategy

and gender disparity on achievement, retention of basic science and technology students in Nasarawa state, Nigeria. Specifically, the study attempted to:

1. find out the posttest achievement scores of students taught Basic Science and Technology concepts using sensory stimulation strategy relative to their counterparts taught using conventional lecture method.
2. find out the retention scores of students taught Basic Science and Technology concepts using sensory stimulation strategy and conventional lecture method.
3. determine the interaction effect of gender on achievement of students taught BST concepts using sensory stimulation strategy.
4. determine the interaction effect of gender on retention of students taught BST concepts using sensory stimulation strategy.

**Research Questions**

The following research questions were posed to guide the investigation:

1. What are the mean achievement scores of students taught BST concepts using sensory stimulation strategy in comparison to conventional lecture method?
2. What are the mean retention scores of students taught BST concepts using sensory stimulation strategy and their counterparts taught using the conventional lecture method?
3. What is the interaction effect of gender on achievement of Students taught BST concepts using sensory stimulation strategy?
4. What is the interaction effect of gender on retention of students taught BST concepts using sensory stimulation strategy?

**Statement of Hypotheses**

Four null hypotheses were formulated and tested at 0.05 level of significance. They are:

$Ho_1$: There is no significant difference in the mean achievement scores of students taught BST concepts using sensory stimulation strategy and the conventional method.

$Ho_2$: There is no significant difference in the mean retention scores of students taught BST concepts using sensory stimulation strategy and the conventional method.

$Ho_3$: There is no interactive effect of gender on the mean achievement scores of students taught BST concepts using sensory stimulation strategy.

$Ho_4$: There is no interactive effect of gender on the mean retention scores of students taught BST concepts using sensory stimulation strategy.

**Methodology**

The study adopted quasi-experimental design involving pre-test, posttest, post posttest control group. The population of the study consists of 3050 JSII students of 41 public co-educational junior secondary schools in Karu LGA of Nasarawa State, Nigeria for 2017/2018 academic session. Findings of the study can easily be generalized and constitute a good representation of the entire state. Moreover, same scheme, same syllabus and teachers with equivalent qualifications are employed throughout the state public schools; and students are being prepared for the same Basic Education Certificate Examinations (BECE) which covers the entire state. Through multi-stage random sampling, 2 intact and equivalent JSII classes were selected

with sample size of 145. Using balloting, one of the classes was assigned as experimental group taught using sensory stimulation strategy and the other was the control group taught using conventional lecture method. The instrument used for data collection is Basic Science and Technology Achievement Test (BSTAT) comprised 40-item multiple-choice questions extracted from standard BECE questions and based on BST concepts of "Energy and Principles of energy-based appliances. A table of specification was used and each item in the test was classified using the modified Bloom's taxonomy of Educational objectives into three levels of cognitive domain for junior students: knowledge, comprehension and application. The test items were further subjected to validation by experts. The reliability coefficient was estimated to be 0.82 and analyzed using Spearman Brown order correlation.

Three different lesson plans were prepared and used for each instructional delivery approach. The analysis of pre-test scores and the emergence of two similar groups took one week. The real experimental teaching was carried out for four weeks duration after the pretest. The posttest was administered as soon as the last class session was over, while the post posttest came up two weeks after the posttest. Data collected were analyzed using mean, standard deviation and ANCOVA statistics.

**Results**

**Research Question 1** What are the mean achievement scores of students taught BST concepts using sensory stimulation strategy in comparison to conventional lecture method?

**Table 1: Mean Scores of Students Taught BST Concepts using Sensory Stimulation Strategy**

| Groups | Pretest Mean ($\bar{x}$) | Pretest SD. | Posttest Mean ($\bar{x}$) | Posttest SD | N | Mean Gain |
|---|---|---|---|---|---|---|
| Control | 14.07 | 4.239 | 23.11 | 3.894 | 88 | 9.54 |
| Sensory stimulation | 14.09 | 3.466 | 27.44 | 3.417 | 57 | 13.35 |
| Total | 14.29 | 3.715 | 24.96 | 3.872 | 145 | |

Table 1 shows the mean posttest scores of the two groups, the mean gain scores and the standard deviations for the groups. The result revealed that the higher mean gain of 13.35 was for group taught using sensory stimulation strategy and control (conventional method) had the least mean gain of 9.54. The extent of dispersion is closer for the posttest than the pre-test for all groups. Students gained more knowledge with the use of sensory stimulation strategy after the administration of the treatment and posttest.

**Research Question 2** What are the mean retention scores of students taught BST concepts using Sensory stimulation strategy and their counterparts taught using conventional lecture method?

**Table 2: Mean Retention Score of Students Taught BST Concepts Using Treatments**

| Group | Posttest Mean ($\bar{x}$) | Posttest SD | Retention Mean ($\bar{x}$) | Retention S D | N | Mean Loss |
|---|---|---|---|---|---|---|
| Control | 23.11 | 3.894 | 20.35 | 3.404 | 88 | 2.76 |
| Sensory stimulation | 27.44 | 3.417 | 25.67 | 3.602 | 57 | 1.77 |
| Total | 24.96 | 3.872 | 22.72 | 3.880 | 145 | |

Table 2 reveals that after the administration of the posttest and the post posttest, there were differences in retention capacity. The findings show that with mean loss of 2.76 for the control after the posttest and post posttest had been administered. The study shows that posttest and post posttest on sensory stimulation strategy had the least mean loss of 1.77. The retention standard deviation produced remarkably higher spread for group that received treatment using sensory stimulation.

**Research Question 3** What is the interaction effect of gender on achievement of Students taught BST concepts using sensory stimulation strategy?

**Table 3: Interaction Effect of Gender on Achievement of Students taught BST Concepts after Treatments have been administered**

| Gender | Groups | Pretest Mean ($\bar{x}$) | Pretest SD | Posttest Mean ($\bar{x}$) | Posttest S D | N | Mean Gain |
|---|---|---|---|---|---|---|---|
| | Control | 14.39 | 4.706 | 24.20 | 3.974 | 44 | 9.81 |
| Male | Sensory stimulation | 13.87 | 3.721 | 27.63 | 3.528 | 30 | 13.76 |
| | Total | 14.54 | 3.934 | 25.67 | 3.749 | 74 | |
| | Control | 12.75 | 3.584 | 22.02 | 3.527 | 44 | 9.27 |
| Female | Sensory stimulation | 14.33 | 3.211 | 27.22 | 3.344 | 27 | 12.89 |
| | Total | 14.01 | 3.460 | 24.18 | 3.873 | 71 | |
| | Control | 13.57 | 4.239 | 23.11 | 3.894 | 88 | 9.54 |
| Total | Sensory stimulation | 14.09 | 3.466 | 27.44 | 3.417 | 57 | 13.35 |
| | Total | 14.29 | 3.715 | 24.96 | 3.872 | 145 | |

Table 3 shows the mean scores, the standard deviations and the mean gain scores of gender on achievement for the groups. For the various groups, the male had higher mean gain score. Males taught using the sensory stimulation strategy had the higher mean gain of 13.76 and their female counterparts taught using sensory stimulation had 12.89. Male and female students had higher mean gains when taught using sensory stimulation than conventional method.

**Research Question 4** What is the interaction effect of gender on retention of students taught BST concepts using sensory stimulation strategy?

**Table 4: Interaction Effect of Gender on Retention after Administering Treatments**

| Gender | Groups | Posttest Mean ($\bar{x}$) | Posttest SD | Retention Mean ($\bar{x}$) | Retention S D | N | Mean Loss diff. |
|---|---|---|---|---|---|---|---|
| | Control | 24.20 | 3.974 | 21.11 | 3.578 | 44 | 3.09 |
| Male | Sensory stimulation | 27.63 | 3.528 | 25.70 | 3.825 | 30 | 1.93 |
| | **Total** | **25.67** | **3.749** | **23.26** | **3.852** | **74** | |
| | Control | 22.02 | 3.527 | 19.59 | 3.075 | 44 | 2.43 |
| Female | Sensory stimulation | 27.22 | 3.344 | 25.63 | 3.410 | 27 | 1.59 |
| | **Total** | **24.18** | **3.873** | **22.14** | **3.846** | **71** | |
| | Control | 23.11 | 3.894 | 20.35 | 3.404 | 88 | 2.76 |
| Total | Sensory stimulation | 27.44 | 3.417 | 25.67 | 3.602 | 57 | 1.77 |
| | **Total** | **24.96** | **3.872** | **22.72** | **3.880** | **145** | |

Table 4 shows the posttest and retention mean scores, standard deviations and mean loss difference on gender and groups. The study shows that the mean interaction effect of male students and control has the higher mean loss difference of 3.09; male students and sensory stimulation strategy had the least mean loss difference of 1.93. The interaction effect of female students on treatment shows that female students and control had the higher mean loss of 2.43; female students and sensory stimulation strategy had the least mean loss of 1.59

**$Ho_1$:** There is no significant difference in the mean achievement scores of students taught BST concepts using sensory stimulation strategy and the conventional method.

**Table 5: ANCOVA Test on the Effects of Mean Posttest on Achievement in BST Concepts**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1244.400[a] | 3 | 414.800 | 45.371 | .000 | .399 |
| Intercept | 4310.515 | 1 | 4310.515 | 471.481 | .000 | .697 |
| Treatment | 580.464 | 2 | 290.232 | 31.745 | .000 | .236 |
| Pretest Scores | 587.624 | 1 | 587.624 | 64.274 | .000 | .239 |
| Error | 1874.213 | 205 | 9.143 | | | |
| Total | 133294.000 | 209 | | | | |
| Corrected Total | 3118.612 | 208 | | | | |

a. R Squared = .399 (Adjusted R Squared = .390)

Table 5 reveals that after adjusting for pre-test scores, there was a significant difference of posttest on students' achievement. [$F(2, 205) = 31.74$, $P<0.05$, Partial $\eta^2 = .236$; $R^2=.055$]. The implication of this is that since p-value (.000) of the F-ratio was significant, it follows that the null hypothesis on the mean posttest scores and difference of treatment was rejected. Therefore, the R Squared shows that the independent variables accounted for only 5.5% of the variation in the treatment and posttest scores of students' achievement in BST concepts. The estimated partial Eta squared indicates that the treatments accounted for 23.6% of the variance observed in the posttest score.

**Table 6: Comparisons of Groups on Students' Achievement in BST Concepts**

| **Treatment** | **Mean (I-J)** | **Std. Error** | **Sig.[b]** | **(95% Conf. Interval for Difference[b]** | |
|---|---|---|---|---|---|
| | | | | Lower Limit | Upper Limit |
| **Control** | 1.294* | 0.509 | 0.012 | 0.291 | 2.297 |
| **Sensory Stimulation** | -2.790* | 0.556 | 0.000 | -3.887 | -1.693 |
| **Based on estimate marginal means** | | | | | |

*. The mean difference is significant at the .05 level.

b. Adjustment for Multiple Comparisons: Least Significant Difference (equivalent to no adjustments).

The post-hoc test result presented in Table 11 shows the differences between the experimental groups after the posttest. The result reveals that there is a significant mean difference between control and sensory stimulation ($p = .000$; $p<.05$)

**$Ho_2$:** There is no significant difference in the mean retention scores of students taught BST concepts using sensory stimulation strategy and the conventional method.

**Table 7: ANCOVA Test on Comparisons of Experimental Groups on Students Retention**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1489.948[a] | 3 | 496.649 | 62.007 | .000 | .476 |
| Intercept | 3651.203 | 1 | 3651.203 | 455.857 | .000 | .690 |
| Treatment | 897.037 | 2 | 448.519 | 55.998 | .000 | .353 |
| Posttest Scores | 475.524 | 1 | 475.524 | 59.370 | .000 | .225 |
| Error | 1641.957 | 205 | 8.010 | | | |
| Total | 111041.000 | 209 | | | | |
| Corrected Total | 3131.904 | 208 | | | | |

a. R Squared = .476 (Adjusted R Squared = .468)

Table 7 revealed that after adjusting for posttest scores and the retention test (post posttest) there was a significant difference of treatments on retention scores [F(2, 205) = 55.99, P<0.05, Partial $\eta^2$ = .353 $R^2$=.124]. The inference on this is that since p-value (.000) of the F-ratio was significant, the null hypothesis on the mean retention scores of students was rejected. The study further reveals that R Squared shows that the independent variables accounted for only 12.4% of the variation in the treatment and posttest scores of students' achievement of BST concepts. The estimated partial Eta squared indicates that the treatments accounted for 35.3% of the variance observed in the posttest score.

**Table 8: Comparisons of Groups on Students Retention in BST Concepts**

| Treatment | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|
| | | | | Lower Limit | Upper Limit |
| **Control** | 2.221* | .476 | .000 | 1.283 | 3.160 |
| **Sensory stimulation** | -2.877* | .521 | .000 | -3.903 | -1.850 |

Centred on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Minimal Significant Difference (equivalent to no adjustments).

The post-hoc test presented in Table 8 shows where the mean differences between the experimental groups lie after the retention test. The result shows that there is a significant mean difference between control and sensory stimulation ($p = .000$; $p<.05$)

**$Ho_3$:** There is no interactive effect of gender on the mean achievement scores of students taught BST concepts using sensory stimulation strategy.

**Table 9: Comparisons of Gender Groups on Students Achievement in BST concepts**

| Gender | Mean Difference (I-J) | Std. Error | Sig.[b] | 95% Confidence Interval for Difference[b] | |
|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound |
| Female | 1.223* | .466 | .009 | .305 | 2.141 |
| Male | -1.223* | .466 | .009 | -2.141 | -.305 |

Centred on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Table 9 shows the post-hoc test between gender and groups, where the difference between the treatments groups lie after the posttest in Basic Science and Technology. ANCOVA test on effect of gender on achievement on BST concepts shows there was a significant interaction effect of gender on the posttest scores of student [$F(1, 205) = 6.04$, $P<0.05$, Partial $\eta^2 = .029$ $R^2=.00084$]. The implication of this is that since p-value (.000) of the F-ratio was significant, it follows that the null hypothesis of interaction effect of gender on the mean posttest scores was rejected. Therefore, the R Squared shows that the independent variables accounted for only .08% of the variation of gender on posttest of students taught BST concepts using the innovative strategies. The estimated partial Eta squared indicates that the treatments accounted for 2.9% of the variance observed in the posttest score.

**$Ho_4$:** There is no interactive effect of gender on the mean retention scores of students taught BST concepts using sensory stimulation strategy.

**Table 10: ANCOVA Test on Effects of Gender &Mean Retention Scores of Students**

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 673.985[a] | 3 | 224.662 | 18.738 | .000 | .215 |
| Intercept | 3317.430 | 1 | 3317.430 | 276.687 | .000 | .574 |
| Gender | 60.391 | 1 | 60.391 | 5.037 | .026 | .024 |
| Posttest Scores | 603.885 | 1 | 603.885 | 50.366 | .000 | .197 |
| Gender * Posttest Scores | 40.899 | 1 | 40.899 | 3.411 | .066 | .016 |
| Error | 2457.919 | 205 | 11.990 | | | |
| Total | 111041.000 | 209 | | | | |
| Corrected Total | 3131.904 | 208 | | | | |

a. R Squared = .215 (Adjusted R Squared = .204).

Table 10 shows that there was no significant interaction effect of gender and treatments on the retention score of student [F(1, 205) = 3.41, P>0.05, Partial $\eta^2$ = .016 $R^2$=.00025]. The implication of this is that since p-value (.000) of the F-ratio was not significant, it follows that the null hypothesis on the interaction effect of gender and retention scores was accepted. Therefore, the Squared shows that the independent variables accounted for only .02% of the variation in the interaction effect of gender on retention of students' in BST concepts. The estimated partial Eta squared indicates that gender and mean retention score accounted for 1.6% of the variance observed in the post-posttest.

**Discussion of Results**

The findings of the research questions passed in the study that students taught Basic Science and Technology using sensory simulation strategy achieved higher and retained more of what they learned in Basic science technology compared to their counterparts who were taught using conventional method. Similarly, the Hypotheses tested revealed proved a significant difference in achievement and retention between the two groups. This finding is in conformity with that of Strom, Ytrehus and Grov (2016) who conducted a study on persons living with dementia and found out that sensory stimulation helped to increase alertness, reduce agitation and improve quality of their lives by making learning pleasurable. All categories of learners benefit from multisensory instruction including

learners who do not have learning and retention problem (Morin & Wilson, 2015).

The findings of the study also agree with results of an action research carried out in Norway by Lykkeslet, Gjengedal, Skrondal and Storjord (2014) in which variety of sensory stimulation intervention were tried to see if they could improve the interaction between health care workers and patients with behavioural and perceptual problem of easy forgetfulness. Their retention level was high after the use of the innovative strategy. This enabled the building of better relationship and interaction with their teachers and care givers. This finding is further supported by Agu and Esson (2017) who asserted that Computer assisted instruction (CAI) appeals to the sensory organs and also enables achievement and interest level of Mechanical Engineering Craft Practice students in Technical Colleges. In terms of gender, no significant interactive effect was observed between male and female students which conform to that of Ugwu and Nzewi (2015) who investigated effects of two instructional delivery approaches on senior secondary schools students' achievement in Biology.

**Conclusion**

Based on the findings of this study, the following conclusions are made:

(1) Achievement and retention of students taught Basic Science and Technology using sensory stimulation teaching strategy are significantly higher than those taught using conventional lecture method. Sensory stimulation strategy was found to be far
(2) more effective than conventional lecture method.
(3) No significant difference was found in the interactive effect of gender on achievement and retention respectively; though, male students' mean gain was higher for group taught using sensory stimulation than their female colleagues, but female students taught with sensory stimulation had better retention compared to their male counterparts.

**Recommendation**

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

(1) Teachers should be encouraged to incorporate the Sensory Stimulation teaching strategy in their instructional delivery approaches Basic Science and Technology.
(2) Efforts should be made by school heads and administrators to provide facilities and materials that appeal to students sense organs of perception. The study has shown that multiple appeals by more than two or three sense organs at a time enhances achievement and increases retention capacity of students.
(3) Seminars and conferences should be organized by supervisory authorities to sensitize teachers on the benefits of sensory stimulation.

(4) The strategy should be included in scheme of work and syllabuses of Science and technology-based subjects.

(5) Researchers, publishers and authors of textbooks in Basic Science and Technology should incorporate and emphasize sensory stimulation as an innovative teaching strategy in the teaching-learning procedures being recommended.

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