

Effect of self-directed learning instructional strategy on students' achievement and retention in Mathematics and Physics in Calabar Municipality of Cross River State, Nigeria

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Abstract

This paper investigated the effect of self-directed learning instructional strategy on students' achievement and retention in Mathematics and Physics. The research design employed was pretest-post test control quasi experimental design. Multi-stage random sampling technique was used to select 120 students who participated in the study. Mathematics/Physics Achievement Test (MPAT), used as Pre-Test (PREMPAT), Post-Test (POSTMPAT), and Post-Post-Test (PPMPAT) was developed by the researchers and validated by experts. The reliability coefficient of the instrument obtained using Spearman-Brown Prophecy formula was 0.68. Three hypotheses were formulated and tested at 0.5 level of significance. The control group was taught Mathematics and Physics for three weeks using only the conventional method while the experimental group was also taught Mathematics and Physics for three weeks with self-directed learning strategy. POSTMPAT was administered to all the subjects at the end of the third week. Two weeks after the administration of POSTMPAT, the PPMPAT was administered to both groups. The results show that the students taught Mathematics and Physics using self-directed learning strategy achieved and retained better than those taught with conventional method. It was also discovered that gender had no influence on the achievement and retention of those exposed to treatment.

Keywords: Achievement, Mathematics, Physics, Retention, Self-directed, learning

Introduction

The importance of Mathematics and Physics in the development of any nation cannot be underrated, especially in Nigeria. It has been asserted that without the knowledge of Mathematics and Science, there cannot be any modern developed society. It is

therefore important that Nigerian students should be well prepared with the required knowledge that will enable them have a meaningful future. Mathematics and Physics have often proven to be difficult subjects for many students, containing many abstract concepts which are central to further learning in both subjects and other sciences (Nwosu, 2004). These abstract concepts are important because they cannot be easily understood if these underpinning concepts are not sufficiently grasped by students; and this had led to poor academic achievement in Mathematics and Physics. Njoku (2007), Asikhia (2010), and Eze and Egbo (2007) have attributed the observed students' poor achievement in science subjects to the use of inappropriate or ineffective teaching method by Mathematics and Physics teachers. Some Nigerian secondary school Science teachers use the traditional method with occasional teacher dominated experiments which make students passive learners. Conventional or traditional method does not encourage meaningful student-teacher, student-students and student-material interaction. It also hinders activities for developing scientific reasoning and skill processes.

Learning is a purposeful process and usually is determined through behavioural activities related to information-seeking and the learner consciously accepts responsibility for decisions relating to the objectives and activities (Carson, 2012). One of the most important characteristics of learning is readiness for self-directed and independent learning. Self-directed learning is a process in which an individual takes the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcome. It builds in opportunities for active engagement in a learning environment which decisively shape individual understanding (Morris, 1995). When students have little or misconstrued knowledge of a certain topic, direct experience is required to gain that understanding and create, change or refine a mental model. The teacher provides a conducive learning environment for the students and guides the students. The teacher also observes the participants' challenges and helps them out.

Self-directed learning readiness helps to expand and enhance learning; this is an important goal of higher education, so understanding how to use these strategies by students is very important. Haggerty (2000) examined engaging adult learners in self-directed learning and its impact on learning styles and found a positive relationship between self-directed learning and academic achievement. Harriman (1990) established the relationship between self-directed learning readiness, completion and achievement in a community college telecourse programme and found that self-directed learning relates to academic achievement. Also Hsu and Shiue (2005) examined the effect of self-directed learning readiness on achievement comparing face-to-face and two-way distance learning instruction and found self-directed

learning to predict students' academic achievement. Similarly, Stewart (2007) investigated the link between self-directed learning readiness and project-based learning outcome and found self-directed learning to relate to learning outcome. Cazana and Schiopca (2013) examined self-directed learning, personality traits and academic achievement and found that self-directed learning and personality traits are correlated, and that self-directed learning predicts academic achievement.

Mari (2002) maintained that teaching strategies is a variable that can easily be manipulated by teachers to increase student's retention rate and performance as well as reduce or eliminate sex-related difference in science and Mathematics. Agomuoh (2010) and Ukozor (2011) reported that male students perform better than females in Chemistry, Physics, Biology and Mathematics, while Olom (2010), and Aniodoh and Egbo (2013) revealed significant differences in favour of females. Ogunleye and Babajide (2011) observed that science subjects such as Chemistry, Physics, Biology, Mathematics are given masculine outlook by many educationists which imply that women and girls grapple with a lot of difficulties (Okeke, 2007). The females' non-involvement in scientific studies has created males dominance in technological advancement in Nigeria. However, Udousoro (2011) showed that gender has no significant effect on science achievement. Although boys and girls differ in their physical, emotional and intellectual development, efforts to link gender difference to intellectual capabilities have however proved untenable (Orimogunje, 2006). Udo and Udofia (2014) reported that gender has a significant influence on students' performance in the area of symbols, formulae and equations, with the male outperforming their female counterparts. In many Nigerian schools, female students are presumed to evade the study of Mathematics and Science due to several factors, like psychological, motivation and interest. Women scientists are very few in Nigeria though the National Population Census (FGN, 2006) clearly showed that the population of females out-numbers that of males. The issue of how male or female students learn and retain Mathematics and Physics concepts is a source of concern. Therefore, teaching method that would benefit both sexes should be adopted by the Mathematics and Physics teachers.

Research Questions

The following questions were posed to guide the study.

1. What are the mean achievement scores of students taught Mathematics and Physics with self-directed learning strategy and those taught with conventional method?
2. What are the mean retention scores of students taught Mathematics and Physics with self- directed learning strategy and those taught with conventional method?
3. What are the mean achievement scores of male and female students taught Mathematics and Physics using self-directed learning strategy?

Hypotheses

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

Ho1: There is no significant difference in the mean achievement scores of students taught Mathematics and Physics with self-directed learning strategy and those taught with conventional method.

Ho2: There is no significant difference in the mean retention score of students exposed to Mathematics and Physics with self-directed learning strategy and those exposed through the conventional method.

Ho3: There is no significant difference in the mean achievement scores of male and female students taught Mathematics and Physics using self-directed learning strategy.

Methodology

The research design adopted was pretest-posttest control group quasi-experimental design. Two intact classes were assigned to the Control group (C) and the Experimental group (E) each. The target population of the study was Senior Secondary II (SS2) Science students from public secondary schools in Calabar Municipality Local Government Area of Cross River State. Multi-stage random sampling technique was employed during sampling. The coeducational schools were selected from the study area and two schools were later randomly selected. An intact class was randomly selected from each of the two schools. One of the intact classes was randomly selected to serve as the experimental group, while the other was used as the control group. The sample for this study consisted of 120 SS2 science students, sixty (60) from experimental group, while sixty (60) was from control group of which 34 were female while 26 were male from each group.

The instrument used for data collection was the Mathematics/Physics Achievement Test (MPAT), used as Pre-Test (PREMPAT), Post-Test (POSTMPAT), and Post-Post-Test (PPMPAT). The POSTMPAT was used to determine achievement after treatment while the PPMPAT was used to determine retention in self-directed learning strategy. These instruments (though the same except in the serial arrangement) were made up of 40 multiple choice objective test items which were selected from past UTME and SSCE questions on Mathematics and Physics based on SS 2 syllabus; twenty (20) questions were selected for each subject. The test items selected were distributed among the six intellectual levels of Bloom's taxonomy in the cognitive domain. The Mathematics/Physics Achievement Test (MPAT) was subjected to face and content validity. In order to ensure the reliability of the instrument (MPAT), a pilot study was done. The reliability coefficient obtained using Spearman-Brown Prophecy formula was 0.68. The research assistants who were the Mathematics/Physics teachers in the sampled schools were trained by the researchers on how the teaching was to be carried out. A pretest (PREMPAT) was administered to subjects in both groups to measure

and to determine their academic achievement in the subjects. The control group was taught Mathematics/Physics for three weeks using only the conventional method and the experimental group was taught Mathematics/Physics for three weeks with self-directed learning strategies. At the end of the three weeks, the POSTMPAT was administered to all the subjects. Two weeks after the administration of POSTMPAT, the PPMPAT was administered to both groups to measure students' retention ability. The data generated from the study was analysed using One Way Analysis of Covariance

Presentation of results

The results of the analysis are presented in the tables 1, 2 and 3. The hypotheses were tested at .05 significant level.

Ho1: There is no significant difference in the mean achievement scores of students taught Mathematics and Physics with self-directed learning strategy and those taught with conventional method.

The independent variables in this hypothesis are self-directed learning strategy and traditional method, while the dependent variable is students' academic achievement in Mathematics and physics. One-way Analysis of Covariance (ANCOVA) was adopted and the result is presented in Table 1.

Table 1: One way ANCOVA results of students' achievement scores in POSTMPAT

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5773.856 ^a	2	2886.928	119.248	.000	.671
Intercept	1266.907	1	1266.907	52.331	.000	.309
Pre-test	2055.322	1	2055.322	84.897	.000	.420
Group	696.884	1	696.884	28.786*	.000	.197
Error	2832.511	117	24.209			
Total	142340.000	120				
Corrected Total	8606.367	119				

a. R Squared = .671 (Adjusted R Squared = .668)

*Significant at $p < 0.05$ alpha level

Table 1 shows the summary of the one way ANCOVA on students' achievement in MPAT. The result revealed that the noted difference in the mean achievement scores in the experimental group and control group is significant at 0.05 alpha level ($F=28.786$; $p=.000$). Therefore, the null hypothesis (H_0) was rejected showing that there is a significant difference in mean achievement scores of students taught using self-directed learning strategy and those taught using conventional method. The result also shows the partial Eta squared estimate which is a measure of effect size as .197. This implies that treatment accounted for 19.7 percent of variance observed in the post-test scores of self-directed learning strategy in students' academic achievement in Mathematics and Physics. Also the R squared value is .671. This suggested that about 67.1 percent of the variation in the dependent variable (student academic achievement in Mathematics and Physics) can be accounted for by treatment.

Ho2: There is no significant difference in the mean retention score of students exposed to Mathematics and Physics with self-directed learning strategy and those exposed to with conventional method.

The independent variables in this hypothesis are self-directed learning strategy and traditional method, while the dependent variable is students' retention in Mathematics and Physics. One-way Analysis of Covariance (ANCOVA) was adopted and the result is presented in table 2.

Table 2: One - Way ANCOVA results of students’ retention scores in retention test (PPMPAT) of self-directed learning strategy and conventional method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4067.759 ^a	2	2033.879	104.195	.000	.640
Intercept	971.619	1	971.619	49.776	.000	.298
Pre-test	3559.350	1	3559.350	182.344	.000	.609
Group	100.503	1	100.503	5.149*	.001	.042
Error	2283.833	117	19.520			
Total	169671.000	120				
Corrected Total	6351.592	119				

a. R Squared = .640 (Adjusted R Squared = .634)

*Significant at $p < 0.05$ alpha level

Table 2 reveals that the noted difference between the mean retention score of students taught Mathematics and Physics using self-directed learning strategy and those taught using conventional method is significant at 0.05 alpha levels ($F=5.149$; $p=.001$). The null hypothesis (H_02) was rejected showing that there is a significant difference in mean retention scores of students taught Mathematics and Physics using self-directed learning strategy and those taught using conventional method. The result also shows the partial Eta squared estimate which is a measure of effect size as .042. This implies that treatment accounted for 4.2 percent of variance observed in the post-test scores of self-directed learning strategy in students’ retention in Mathematics and Physics. Also the R squared value is .640. This suggests that about 64.0 percent of the variation in the dependent variable (student academic retention in Mathematics and Physics) can be accounted for by treatment.

H₀₃: There is no significant difference in mean achievement scores of male and female students taught Mathematics and Physics using self-directed learning strategy.

The independent variable in this hypothesis is gender while the dependent variable is students’ academic achievement in Mathematics and Physics. One-way Analysis of Covariance (ANCOVA) was adopted and the result is presented in Table 3.

Table 3: One Way ANCOVA result of male and female students' achievement score (experimental group)

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	559.820 ^a	2	279.910	9.616	.000	.252
Intercept	506.674	1	506.674	17.407	.000	.234
Pre-test	530.920	1	530.920	18.240	.000	.242
Gender	53.860	1	53.860	1.850	.168	.031
Error	1659.163	57	29.108			
Total	48645.000	60				
Corrected Total	2218.983	59				

a. R Squared = .252 (Adjusted R Squared = .251)

Not Significant as $p > 0.05$ alpha level

Table 3 shows the summary of one way ANCOVA of achievement mean scores of male and female students exposed to treatment. The results revealed that the noted difference between the mean scores of male and female students is not significant at 0.05 alpha level ($F=1.850$; $p=.168$). The null hypothesis (H_03) was therefore not rejected showing that there is no significant difference in mean score of male and female students who were taught Mathematics and Physics via Self-directed learning strategies.

Discussion of the findings

It was discovered that the students in the experimental group performed and retained better than those in the control group. This report is consistent with Njoku (2007), Asikhia (2010) and Eze and Egbo (2007) who attributed students' poor achievement in science subjects to the use of inappropriate or ineffective teaching method by Mathematics and Physics teachers. The study also was in agreement with those conducted by Haggerty (2000) and Harriman (1990) who found a positive relationship between self-directed learning and academic achievement. Also Hsu and Shiue (2005) examined the effect of self-directed learning readiness on achievement comparing face-to-face and two-way distance learning instruction and found self-directed learning to predict students' academic achievement. Similarly Stewart (2007) investigated the link between self-directed learning readiness and project-based learning outcome and found Self-directed learning to relate to learning outcome.

This study also found out that there exists a similarity in the performance and retention of male and female students taught using self-directed learning method as confirmed by the result from Table 3. This was in agreement with the work of Udousoro (2011), whose study showed that gender has no significant effect on science achievement. The

study is contradicted to Agomuoh (2010) and Ukozor (2011) who reported that male students perform better than females in Chemistry, Physics, Biology and Mathematics, while Olom (2010), and Aniodoh and Egbo (2013) revealed significant differences in favour of females. The study also contradicted to the finding of Udo and Udofia (2014) who reported that gender has a significant influence on students' performance in the area of symbols, formulae and equations, with the male outperforming their female counterpart.

Conclusion

In view of the findings of this study, the following conclusion were drawn: there is a significant difference in the achievement of SS2 students taught Mathematics and Physics using self-directed learning strategy and those taught with conventional method. Students taught Mathematics and Physics using self-directed learning strategy retain more than those taught with conventional method. There is no gender disparity in the achievement and retention of concept learnt by those students taught Mathematics and Physics with self-directed learning strategy. Self-directed Learning strategy is student-centered, activity-based and innovative. The use of self-directed strategy in teaching and learning Mathematics and Physics should be encouraged since most concepts are abstract in nature. Self-directed learning strategies reduce tension (anxiety) and lack of interest but generate fun in the classroom thereby making the lesson interesting.

Recommendations

Following the outcome of the research, the following, were recommended:

- i) Self-directed learning strategy is more advantageous in teaching and should be encouraged in schools.
- ii) There is no gender disparity in retention of what is taught, and so gender bias should be discouraged.
- iii) Because of several other advantages of the method, teachers should be given some training in this regard, to promote the teaching strategy and should be encouraged to use or adopt it generally and especially in Mathematics and Physics.

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