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Effect of Teachers' Instructional Strategy Pattern on Senior Secondary School Students' Performance in Mathematics Word Problems in Ondo, Nigeria

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Abstract

The study examined the effect of Instructional strategy pattern on the performance of Nigerian Senior Secondary School Students in Mathematics word problems. A total number of 125 Senior Secondary II Students were purposively sampled from two schools in Ondo town of Ondo State, Nigeria. The research type was quasi-experimental involving a 2 x 3 Factorial design. The dependent variable is students' performance on the test items administered while the independent variables weres instructional strategy pattern and the scoring levels (high, medium and low scorers). Two hypotheses were formulated and tested using Analysis of Covariance (ANCOVA) at alpha level of 0.05 to determine significant level. Findings from the study showed that the experimental group exposed to Instructional strategy pattern performed significantly better in Mathematics word problems-solving involving simultaneous equations than their counterparts in the control group. Based on the findings, it is recommended among others that teachers of mathematics should adopt the use of Instructional strategy patterns in teaching Mathematics in Secondary Schools.

Keywords: Instructional Strategy, Word Problem Solving, Pattern, Academic Performance.

1. Introduction

Mathematics is one of the core courses in Nigerian Secondary Schools. Studies in Mathematics have shown that the mode of instruction, especially at the secondary school level remains overwhelmingly teacher-centered, with greater emphasis on the lecture mode of instruction and the use of textbook than engaging students in critical thinking across subject area and applying the knowledge acquired to real-world situations (Butty, 2001). The teacher is the most indispensable factor in effective administration of any education system. Also, it has been established that no amount of resources put into the nation education system, without adequately prepared and motivated teachers, nothing tangible can ever be achieved from the system. The role of teachers at all levels of education is emphasized in the National Policy on Education (FRN, 2004) that no educational system may rise above the quality of its teachers. This declaration in the policy document underscores the need for teachers' effectiveness in teaching and learning. Eso (1998) conceptualized teachers' effectiveness as the managerial skills essential for enhancing classroom control and discipline. It is the teachers' competence, ability, resourcefulness, and ingenuity through effective utilization of appropriate language, methodology and available instructional materials that could bring out the best from the learners in term of academic achievement.

Stein, Grover, and Henninssen (1996) investigated the use of enhanced instructions as a means of building students' capacity for Mathematics thinking and reasoning. It was found that students must first be provided with opportunities, encouragement and assistance in order to engage in critical thinking, reasoning and brainstorming. Consistent engagement of students in such practices lead students to a deeper understanding of Mathematics as well as increased ability to demonstrate complex problem solving, reasoning and communication skills. The researchers concluded that the tasks used in Mathematics classroom highly influence the kinds of thinking processes that students employ, which in turn influence learning outcomes.

Instructional Strategy or Learning Strategy is a process by which an instruction module, instruction phase, or an entire course is delivered, and it takes the form of conference, demonstration, discussion, lecture, etc. Also, an Instructional Strategy can be described as a sequence of teaching/learning modes designed to promote the attainment of a particular type of objective (Farrell & Farmer, 1983). Educational research findings have consistently brought to the fore the outstanding learning strategies that characterize effective teaching (Harberman, 1992). These strategies pattern include:

i. Beginning a lesson by stating its objectives and outlining its structure.

ii. Demonstrating effective delivery skills built on clarity, gestures and direct eye contact with learners;

iii. Presenting clear, precise guidelines and routines that make the classroom run smoothly;

iv. Involving the learners actively in the learning task;

v. Scanning the classroom frequently and drawing the learners back to the lesson when attention wanders;

vi. Moving round to supervise and offer help as needed when students work at their desks;

vii. Getting down to students interest level, listening sensitively, and accepting meaningful learner responses that differ from the teacher's view;

viii. Commencing and stopping lessons on time;

ix. Treating the learner with trust and respect and

x. Creating room, for reviews and repetitions especially where difficult tasks are involved.

However, Walker (1998) pointed out that it is not the isolated or haphazard exhibition of these classroom behaviours that produce instructional success but the tight, systematic linkage between the critical components of the instructional process. According to Walker (1998), this represents one of the power constants among the factors that promote learning. Also, Onasanya (1998) described Systems approach as an instructional strategy that described teaching-learning process as an enterprise that consists of several elements such as: the teacher, learner, use of the media, and evaluation of the learning outcome. All these cooperatively interact in order to promote efficient and effective teaching and learning. It is an approach that ensures a more comprehensive consideration of the factors in an instructional setting. It ensures constant monitoring of the instructional process so that any defective part of the system that might affect other parts are promptly detected and corrected. By using instructional strategies in teaching, system approach ensures a careful integration of media material and process into instruction right from the planning phase.

The elements of instructional systems (learner, teacher, media, method, content, evaluation) interact better when instructional strategies are put in place. Farrell and Farmer (1983) designed instructional strategies pattern for lesson presentation and this is presented in figure 1.

In figure 1, Farrell and Farmer (1983) indicated that the nature of contents to be learnt and the intellectual development of students in relation with how humans learn various categories of content serve as the basis for the specific objective of the lesson. The set objectives (the expected change in learners' behavior) determine the instructional strategy the teachers employ in teaching the learners. The sequence of teaching/learning modes and plans for getting and giving feedback is term instructional strategy pattern (Farrell & Farmer, 1983). The instructional strategy pattern is used to elicit feedback from the learners in order to determine whether a meaningful learning has taken place. The feedback received from the learner assist the teachers to modify the instructional strategy pattern used in case the desired change in learners' behaviours does not take place. It is therefore imperative for teachers of Mathematics to appreciate and inculcate in students, positive attitudes towards Mathematics to promote better academic performance. This can be improved through the use of appropriate instructional strategy pattern.

In appreciation of the importance of Mathematics and its relevance to national development, the National Policy on Education (FRN 2004) emphasizes on the need for basic knowledge and application of Mathematics in science and technology for purposeful and meaningful economic development. The policy also reflects that the teaching of problem solving in the classroom is very essential in order to prepare the students for problem-solving challenges outside the four walls of the classroom.

1.1. Statement of the Problem

The poor performance of students in external examinations in Nigeria is of great concern to the government, parents and well meaning Nigerians. It has been observed that the huge investment on education is not yielding the desired dividend (Adebule, 2004). The teachers also complained of students' low performance at both internal and external examinations (Ashiaka, 2010). The annual Senior School Certificate Examinations results showed the general poor performance of students in Mathematics. The trend of performance for the last five years is shown in table 1. In figure 2, it is observed that the highest percentage (57.27%) pass at Credit level was recorded in 2008. This implies that slightly above 50% of candidates would be qualified for admission into the University and other allied tertiary institutions. This also has serious implication for a developing nation aspiring for scientific and technological advancement. Students' poor performance in internal and public examinations in Mathematics have been attributed to teachers' methods of teaching, students' attitudes, unavailability of learning materials among others (National Mathematical Centre, 2009).Further, the obsolete teaching methods and inadequate use of instructional materials in the teaching of Mathematics have also been identified as the main reasons for poor performance in public examinations. This was observed at the Special Skill Improvement Workshop (SKIW) organized for 54 Mathematics teachers drawn from all the 18 Nigerian air Force primary schools across Nigeria (The Punch, May 8, 2011). Also, the West African Senior School Certificate Examinations (WASSCE) Chief Examiners' reports (2003) indicated that candidates demonstrated weakness in word problems and this weakness affected most of them in all questions that required translation of word problems to Mathematical expressions. Similarly, the WASSCE Chief Examiners' reports (2005) revealed that students' performance in word problems is generally poor as many of the candidates could not read and carry out instructions that are required to solve given word problems. Teachers often develop instructional methods or strategies that they thought is appropriate for teaching each topic in their lessons, with the aim of attaining the desired change in behaviors of learners but fail to realize that instructional strategy can be patterned in a way that will stimulate learners' interest to achieve effective learning outcome. To this end, this study investigated the effect of teachers' instructional strategy pattern on students' academic performance when taught Mathematics word problem involving simultaneous equations.

1.1. Purpose of the Study

The main purpose of the study was to examine the effect of instructional strategy pattern on Senior Secondary School Students' academic performance in Mathematics word problem involving simultaneous equations.

Specifically, the study examined:

1. Whether or not there is difference in academic performance of students taught word problem involving simultaneous equations using instructional strategy pattern and their counterparts in the control group.
2. Whether or not there will be a difference in the academic performance of high, medium and low scorers exposed to word problems involving simultaneous equations using instructional strategy pattern.

1.3.Research Questions

The following research questions were raised to guide the conduct of the study:

1. Is there any difference in the academic performance of students taught word problems involving simultaneous equations using instructional strategy pattern and their counterparts in the control group?
2. Is there any difference in the performance of high, medium and low scoring levels of students taught word problems involving simultaneous equations using instructional strategy pattern?

1.4. Research Hypotheses

The following research hypotheses were tested based on the research questions raised:

Hypothesis One

There is no significant difference in the academic performance of students taught word problem involving simultaneous equations using Instructional strategy pattern and their counterparts in the control group

Hypothesis Two

There is no significant difference in the academic performance of high, medium and low scorers students taught word problem involving simultaneous equations using Instructional strategy pattern.

2. Methodology

2.1 Research Design

The study is a quasi-experimental of pre-test, post-test, non-randomize, non equivalent, Control group design involving a 2 x 3 factorial type. The Instructional Strategy is at two levels (Instructional strategy pattern and the lecturing mode), while the scoring level is at three levels (High, Medium and Low).

2.2.Sampling Techniques

The target population for this study was all the Senior Secondary School Students in Ondo town of Ondo State, Nigeria. The selected schools were used as intact classes to avoid disrupting the school program or arrangement. Atotal number of 125 Senior Secondary II Students were involved. The experimental group has 61 students and the control group has 64 students.

The instructional strategy pattern employed by the teacher to engage students in the experimental group in solving word problems involving simultaneous equations is as follows:

- teacher presents the problem
- uses questions and answer techniques to elicit alternative solution(s) to the given problem
- teacher emphasizes desirability of a variety of search strategies from the group members
- individual work/small group discussion (data collection, data analysis, making and testing conjectures)
- teacher asks students to weigh the advantages and disadvantages of proposals and processes which arose from group discussion and/or individual work. While the control group was made to solve word problems involving simultaneous equations without following the above instructional strategy pattern.

2.3. Research Instrument

Basically, the instrument used for the study was a Mathematics Academic Performance Test (MAPT) prepared by the researchers for the purpose of this research. A stimulus instrument (instructional guide) for the teacher was also used. The MAPT comprised 5 theoretical questions on word problems involving simultaneous equations prepared according to the contents and the set behavioural objectives. Each question attracted 20 marks. The instrument was validated by lecturers of Mathematics Education in the Department of Science Education, University of Ilorin, Nigeria. The questions were drawn from the West African School Certificate Examinations past questions and thus assumed to be reliable.

2.4. Procedure for Data Collection

The Mathematics Academic Performance Test (MAPT) was administered as pre-test on students in the two selected Secondary Schools. The Senior Secondary School Two Mathematics teacher from the experimental school received training in the use of the Instructional strategy pattern while the teacher for the control group used the lecture method to teach. After administering the pre-test, the teachers were trained and necessary materials were provided. The teaching lasted for 2 weeks.

At the end of the instruction, the pre-test instrument, that is MAPT, were re-organized and administered as post-test to both the experimental and the control groups, thus marking the end of the experiment.

2.5. Data Analysis Techniques

The MAPT scores formed the basis of data analysis. The research hypotheses 1 was tested with t-test and research hypothesis 2 was tested with Analysis of Covariance (ANCOVA) with pre-test score as covariates. The Schefle and Bonferroni post hoc analysis procedure was also employed to determine the relationship between means of different pairs of groups and the direction of significant difference observed in the ANCOVA.

3. Results

The analyses of the scores collected from the treatment of the study, pre-test and post test of the experimental group (those exposed to instructional strategy pattern) and the control group.

The scores were analyzed using mean scores, standard deviation, t-test analysis and Analysis of Covariance based on the two formulated null hypotheses with an alpha level of 0.05.

3.1. Research Question One

What are the differences in the performance of students taught word problems involving simultaneous equations with instructional strategy pattern and their control group counterparts?

The pre-test and post-test scores of both experimental and control groups were analyzed using mean scores and standard deviation in table 2. The analysis in table 2 revealed that the mean gain score of students exposed to instructional strategy pattern was 9.72 while that of the control group was 5.54. Thus, the mean gain difference between the two groups was 4.18 in favour of experimental group (Instructional strategy pattern).

3.2. Hypothesis One:

There is no significant difference in the students' academic performance when taught word problem leading to simultaneous equations with Instructional strategy pattern and those in the control group.

In order to test whether or not the difference in the means of both the experimental and the control groups was statistically significant, another analysis was conducted as shown in table 3. An independent sample t-test statistic was employed to test for significant difference between the two groups using the pre-test scores and post test scores separately.

Table 3 shows the means and standard error for the pre-test and post-test scores for the experimental group and control group. Here, the Independent sample t-test is employed to determine significant difference between the experimental group and the control group. Comparing the pre-test scores for the two groups, since the p-value (=0.498) > α (=0.05), the null hypothesis was not rejected. Therefore, there is no significant difference between the means of the experimental group and the control group. This implies that using the pre-test scores, the experimental group and the control group are equivalent. Comparing the post-test scores for the two groups; since p-value (=0.003) < α (=0.05), the null hypothesis was rejected. Therefore, the means of the experimental group (61.16) is significantly greater than the means of the control group (55.31). This implies that the effect of the Instructional strategy patterns is significant over the control group.

3.3. Research Question Two

What are the differences in the performance of high, medium and low scoring students taught word problems involving simultaneous equations with instructional strategy pattern?

The pre-test and post-test scores of high, medium and low scorers were analyzed using mean scores and standard deviation in the table below.

The analysis in table 4 showed that the mean gain scores of students that were exposed to instructional strategy pattern as categorized into low, medium and high scoring levels. It was observed in table 4 that students in the low scoring level category have the highest mean gain score of 17.00 followed by those in the medium group with 7.82 and those in the high scoring group having 6.00. To ascertain whether the difference in the means was statistically significant; the hypothesis 2 was tested as shown in table 5:

3.4.Hypothesis Two:

There is no significant difference in the students scoring levels when taught word problem involving simultaneous equations using Instructional strategy pattern.

The students were grouped into three groups based on their performance in the pre-test administered by the researchers. The groups are the Low scorers, the Medium scorers and the High scorers. Analysis of Covariance test was employed to test for significant difference among the three groups.

Table 4 shows the Analysis of Covariance *F*-test with the *F* value of 3.659 at 0.032 significant levels. Thus the probability of the null hypothesis is less than the critical value ($p<0.05$). This implies that there is significant difference in the performance scores of students exposed to instructional strategy pattern at the three different levels of low, medium and high in simultaneous equations. As such the null hypotheses is rejected

4. Discussion

In the study the t-test analysis of hypothesis one revealed that the experimental group exposed to instructional strategy pattern performed significantly in Mathematics word problems involving simultaneous equations better than their control group counterparts. This attests to the efficacy of instructional strategy pattern as a tool for improving students' academic performance in Mathematics especially word problem aspect of Mathematics.

Also, ANCOVA of hypothesis two revealed that differences in the performance of high, medium and low scorers exist when taught Mathematics word problems involving simultaneous equations using instructional strategy pattern

with the low scorers benefiting more, followed by the medium scorers and the high scorers in that order.

5. Conclusion

Findings from the study revealed the efficacy of the instructional strategy pattern in improving students' performance in Mathematics word problems involving simultaneous equations. Other findings from the study include the fact that the strategy pattern was beneficial to all ability levels irrespective of the standard of the members of such groupings. Therefore, it can be established that instructional strategy pattern is more relevant at improving students' academic performance, especially for the weak students.

6. Recommendations

The following recommendations are considered appropriate and relevant based on the findings of the study:

1. Instructional strategy pattern should be used in teaching not only in word problems involving simultaneous equations but also to teach other aspects of Mathematics at both primary and secondary school levels.
2. More time should be allotted to Mathematics lessons (i.e double period)
3. Authors of Mathematics textbooks should clearly state the patterns considered appropriate to teach each topic in their textbooks.

Professional bodies such as the Mathematical Association of Nigeria should encourage the use of the instructional strategy pattern through organized seminars, workshops and conferences for teachers.

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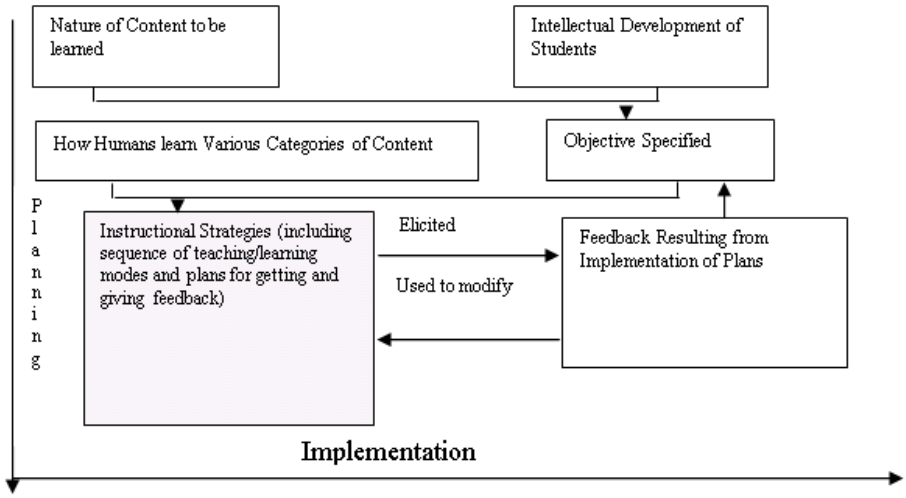

Figure 1: Design of Instructional Strategies

Source: Farrell and Farmer (1983)

Table1: Trend of Students' Performance in WASSCE May/June 2006-2010

YEAR OF ENTRY	TOTAL CANDIDATES THAT SAT FOR THE EXAM	TOTAL NUMBER OF CANDIDATES THAT PASSED AT CREDIT LEVEL.	TOTAL NUMBER OF CANDIDATES THAT PASSED AT ORDINARY PASS LEVEL	TOTAL NUMBER OF CANDIDATES THAT FAILED
2006	1,149,277	472,674	357,325	286,826
		41.12%	31.09%	24.95%
2007	1,249,028	584,024	333,844	302,774
		46.75%	26.72%	24.24%
2008	1,268,213	726,398	302,266	218,618
		57.27%	23.83%	17.23%
2009	1,348,528	634,382	344,635	369,511
		47.09%	25.56%	23.79%
	1,306,535	548,065	363,920	355,382
2010		(41.95%)	(27.85%)	(27.20%)

Source: Statistics Office WAEC, Lagos.

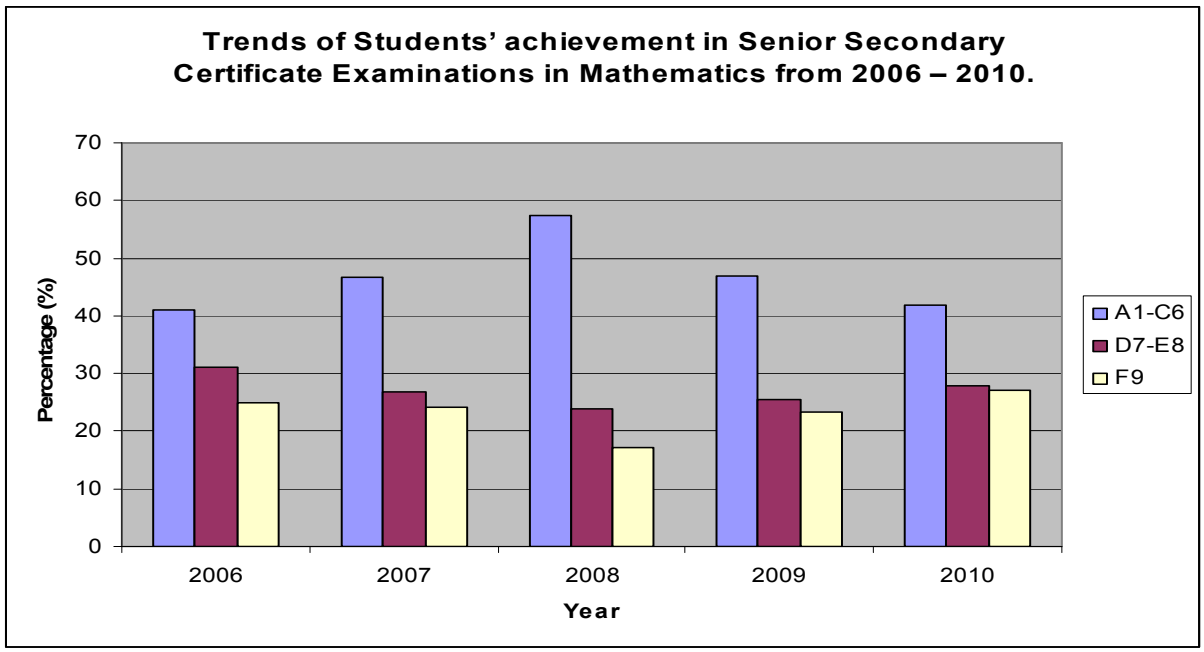

Figure 2: Bar Chart Showing Students' Performance in WASSCE 2006-2010

Table 1: Mean Gain Scores of performance of both Experimental and control groups

Group	Group Statistic	Pre-Test	Post-Test	Mean Gain Scores
Experimental Group	N	61	61	
	Mean	51.44	61.16	9.72
	SD	13.985	10.428	
Control Group	N	64	64	
	Mean	49.77	55.31	5.54
	SD	13.613	10.892	

Table 3: t-test analysis on post-test scores of the experimental and control groups

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		T	Df	Sig. (2-t)	Mean Diff
Pre-Test	Equal variances assumed	0.679	123	0.498	1.677
	Equal variances not assumed	0.679	122.306	0.498	1.677
Post-Test	Equal variances assumed	3.065	123	0.003	5.851
	Equal variances not assumed	3.069	122.997	0.003	5.851

Table 4: Mean Gain Scores of Experimental Group performance based on scoring levels

Group	Group Statistics	Pre-Test	Post-Test	Mean Gain Scores
Low Scorers				
	N	17	17	
	Mean	33.47	50.47	17.00
	SD	4.002	5.614	
Medium Scorers				
	N	22	22	
	Mean	51.09	58.91	7.82
	SD	5.631	5.631	
High Scorers				
	N	22	22	
	Mean	65.68	71.68	6.00
	SD	6.395	6.432	

Table 5. Analysis of Covariance of post-test scores of the categorized experimental groups into low, medium and high scorers

Dependent Variable: Post-Test

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	5395.508[a]	3	1798.503	90.813	.000
Intercept	425.804	1	425.804	21.5	.000
Pre-test (Covariate)	905.974	1	905.974	45.746	.000
Group 2	144.929	2	72.464	3.659	0.032
Error	1128.852	57	19.804		
Total	234727	61			
Corrected Total	6524.361	60			

a. R Squared = .827 (Adjusted R Squared = .818)

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