

Effectiveness of Selected Teaching Strategies in the Remediation of Process Errors Committed by Senior Secondary School Students in Mathematics

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ABSTRACT The purpose of the study was to determine the effectiveness of selected teaching strategies in the remediation of process errors committed by students in mathematics in senior secondary schools. Four hypotheses were formulated to guide the study. The study employed the quasi-experimental design. Sample for the study consisted of two hundred and seven (207) students drawn from six senior secondary schools randomly selected from the three hundred and sixty senior secondary schools in Edo State. The Diagnostic Test on Mathematics (DIATOM) was used to collect data for the study. Data collected were analysed using analysis of covariance (ANCOVA) and z-test for two population proportions. Results of data analysis revealed that the direct instruction was a more effective strategy for the remediation of process errors committed by students in mathematics. Sex and school location were shown not to have had any significant influence on the effectiveness of either strategy. The study recommended that enough practice activities should be given to students during class sessions to assist them develop mastery of content taught.

INTRODUCTION

Mathematics is today regarded as an important subject at both the junior and senior secondary school curriculum. This importance is largely due to the role it plays in the scientific and technological development of a nation. According to Abiodun (1997), while science is the bedrock that provides the spring board for the growth of technology, mathematics is the gate and key to the sciences. Contributing to the increasing importance and contribution of mathematics to the modern culture of science and technology, Ukeje (1997: 3) stated that ... "without mathematics there is no science, without science there is no modern technology and without modern technology there is no modern society. In order words, mathematics is the precursor and the queen of science and technology and the indispensable single element in modern society development". Therefore, any shortcoming in the subject constitutes a draw back in the nation's attainment of her scientific and technological development.

However, performance in the subject in most public examinations seems to have remained poor. Ukeje (1997) observed that analysis of Senior Secondary School Certificate Examinations results in the years 1993, 1994 and 1995 shows the poor state of mathematics education in Nigeria. Other surveys including Buhari (1994),

Aguele (1996) and Ifamuyiwa (1999) revealed that students' performance in the subject continues to decline and almost getting to a dangerous peak. Ifamuyiwa (1999: 51) observed that "the mass failure and consistent poor performance in mathematics which students have shown for over a decade now casts serious doubt on the country's high attainment in science and technology". This situation cannot be allowed to continue without check.

Studies including Osafehiti 1990; Buhari 1994; Brignull 1999; Ifamuyiwa 1999; Harbor-Peters 2001 have offered numerous reasons for students' poor performance in mathematics. Sometimes, the finger is pointed at the teachers suggesting that the subject is not properly taught. At other times the finger is pointed at the subject area, suggesting that mathematics is an unusual and difficult subject. Sometimes the finger is pointed at the students, suggesting they aren't working hard enough or taking the subject seriously. Other studies, Aguele (1996); Usman and Harbor-Peters (1998), have also indicated that other factors are contributing to the poor performance level of students. Among these factors are the process errors committed by students while carrying out mathematical operations. According to Harbor-Peters and Ugwu (1995) teachers inability to diagnose these process errors among other factors have contributed, to a large extent, to students' poor performance in internal and external

examinations. Therefore, if their poor performance must be improved upon, these errors should be identified and remedied. Process skills are thought processes related to cognitive development. They are commonly brought to bear while performing mathematical operations. The errors resulting from the violation or wrong use of these skills are referred to as process errors (Aguale 2004). In the Nigeria setting some studies such as Isineyi (1990); Harbor-Peters and Ugwu (1995); Usman and Harbor-Peters (1998), have attempted to identify these process errors committed by students in some aspects of mathematics. These errors as have been identified by these studies are conceptual, logical, translation and applied errors. Though attempts have been made at identifying process errors committed by students the researchers are however not aware of any work aimed at remedying these process errors that have been identified in Edo State. Hence this study has become necessary.

Remedial teaching is the application of special teaching techniques to overcome difficulties in learning, such as difficulties in forming concepts or faulty learning habits. The main function of remedial teaching is to remove the effects of poor learning or lack of learning. In the teaching of mathematics various methods have been suggested and have been used. However there seems to be no evidence available to the researcher to implicate the effectiveness of any of these strategies in the remediation of process errors committed by students in mathematics in Nigeria. Though Din (1998) have shown that when Direct Instruction (DI) is used effectively it could help students to remedy their basic mathematical skills, there is no evidence to demonstrate its effectiveness in Nigeria setting and in particular in the remediation of process errors. Against this background therefore, this study investigated the effectiveness of DI and the Wilson's learning cycle (WLC) in the remediation of process errors committed by students in mathematics.

The Direct Instruction (DI) or Basic Practice Strategy (BPS), one of the behaviour strategies incorporates stimulus control, reinforcement and modeling. The teaching strategy involves a seven step lesson procedure. These steps according to Montague, Hoffman and Huntsberger (1993) are review of previous prerequisite learning, explicit statement of lesson objectives, presentation of new material, modeling of skill, guided practice, brief review of steps used in performing the skill

and independent practice. For this study a re-teach was introduced to provide for remediation for student with difficulties. The learning cycle, on the other hand as a teaching approach involves students in an active learning process modeled on four elements of Jean Piaget's theory of cognitive development. These are physical experience, social interaction, physical maturation and self regulation (Barman and Allard 1993). The Wilson's learning cycle, one of such learning cycle, consists of the following five steps: Initiating, Abstracting, Schematizing, Consolidating and Transfer (Oduwale and Odiase 1996).

Studies including Isineyi (1990), Ugwu and Harbor-Peters (1995), Usman and Harbor-Peters (1998) observed that the variables of sex and location of school influences the rate of commitment of process errors by students. This study therefore attempted to resolve the following questions:

- (i) Are the Direct Instruction (DI) and Wilson Learning Cycle (WLC) effective in the remediation of process errors?
- (ii) Does the sex of the students affect the effectiveness of the DI and WLC?
- (iii) Does the location of the school of the students influence the effectiveness of the DI and WLC?

The resolution of the above questions constitutes the problem of this study.

METHOD

The study employed the quasi-experimental design. Intact classes of students were used. Opportunity was not provided for randomization of sample as this would affect normal school system, however, the three teaching strategies. Direct Instruction (DI), Wilson Learning Cycle (WLC) and the Lecture method (which served as the control), were randomly assigned to two each of the six classes.

The sample consisted of 207 students drawn from six senior secondary schools out of the three hundred and sixty senior secondary schools in Edo State. The sample was drawn by stratified random sampling technique to ensure the representation of both sexes of students and urban and rural students.

The instrument that was used to collect data for analysis was the Diagnostic Test on Mathematics (DIATOM). The instrument had a pre and post-test. It was constructed by the researchers and validated for the study. A trial testing of the

Instrument yielded reliability coefficients of 0.71 and 0.75 for the pre-test and post-test respectively.

The study employed the test, teach and retest procedure. The pre-test was administered to determine the common errors students commit. They were then taught for three weeks using scheme and lesson plans drawn up for each teaching strategies. Content covered for the study was sequences and series. A post-test was administered to determine how much of the errors have been corrected.

The following hypotheses guided the data analysis.

1. There is no significant difference between the mean errors committed by students when taught with direct instruction, Wilson's learning cycle and the control method
2. There is no significant difference between the mean errors committed by male and female students when taught with direct instruction, Wilson's learning cycle and the control method.
3. There is no significant difference between the mean errors committed by urban and rural students when taught with direct instruction, Wilson's learning cycle and the control method.
4. There is no significant interaction effect between teaching strategies, sex and school location in the remediation of process errors committed by students.

Analysis of Data

The data collected for the study were analysed

using analysis of covariance (ANCOVA) and the z-test for two population proportions. The pre-test scores were used as covariate.

RESULTS

Results of data analysis are shown in table 1. From the table, the main effects were seen to be significant at $p < 0.05$ for the teaching strategies and not significant for gender and school location. This indicated that hypothesis one was rejected while hypotheses two and three were retained. Hypothesis four was also retained, indicating that there was no significant interaction effects of teaching strategies, sex and school location on the remediation of process errors committed by students in mathematics. To ascertain the direction of significance in case of hypothesis one, a post-hoc analysis was done using Turkey's HSD test (see Table 2).

Result of the test revealed that DI was superior to the other strategies in the remediation of process errors committed by students with the least mean of 8.08.

DISCUSSION

Primarily, the study set out to determine the effectiveness of the direct instruction (DI) and the Wilson's learning cycle (WLC) in the remediation of process errors committed by senior secondary school students in mathematics. The study also sought to find out whether school location and gender had any influence on the effectiveness of the teaching strategies.

Results of data analysis indicated that the

Table 1: SANCOVA summary table for DIATOSS scores

<i>Source of variation</i>	<i>Sum of squares</i>	<i>DF</i>	<i>Means square</i>	<i>F</i>	<i>Sing of F</i>
Covariates	3414.775	1	3414.775	191.422	.000
Pre-test	3414.775	1	3414.775	191.42	.000
Main Effects	5628.277	4	1407.057	78.875	.000
Location (LOC)	1.111	1	16.415	0.062	.803
Sex	16.415	1	16.415	.920	.339
Strategy (MTH)	5627.858	2	2813.929	157.740	.000
2-way interactions	316.607	5	63.321	3.550	.54
Sex X Loc	43.689	1	43.689	2.449	.119
Sex X MTH	93.010	2	46.505	2.607	.076
Loc X MTH	123.381	2	61.690	3.458	.063
3-way interactions	26.740	2	13.370	.749	.474
Sex X Loc X MTH	26.740	2	13.370	.749	.474
Explained	9386.349	12	782.196	43.848	.000
Residual	3460.762	194	17.839		
Total	12847.111	206	62.365		

* $P < 0.05$

Table 2: Multiple comparison of mean: Turkey's HSD test

		<i>MDI</i>	<i>MWLC</i>	<i>Conventional</i>
Means	Strategy			
8.08	MDI			
12.26	MWLC	*		
20.65	Conventional	*	*	

$P < 0.05$

Grand Mean 12.44

* = significant

direct instruction was a more effective teaching strategy in the remediation of process errors committed by students. Direct instruction provides enough opportunity for learners to practice skills learnt. This results in the mastery of such skills thus allowing for the remediation of more process errors committed by students. This agrees with the findings of Din (1998) that direct instruction used effectively could help students to remedy their basic mathematical skills.

In the error by error analysis results indicated that the proportion of conceptual errors remedied by DI was 0.923 while that remedied by WLC was 0.727, showing a proportion difference of 0.196 in favour of DI. This proportion difference was found significant at the 0.05 level of significance for a z-test of two population proportions. This implies that the DI was a more effective strategy for the remediation of conceptual errors committed by students in mathematics.

In the case of translation error, the study showed proportion difference of 0.114 in favour of DI. This difference however, was found not significant when tested at $p < 0.05$ using a z-test for two population proportions. This implied that no one strategy appeared to have been more effective than the other in the remediation of translation errors committed by students in mathematics.

For the applied errors a proportion difference of 0.220 in favour of DI was found. This difference was significant at the 0.05 level of significance for a z-test of two population proportions. The implication of this was that the DI appeared to have been a more effective strategy in the remediation of applied errors.

Concerning logical errors, the difference between the proportion of errors remedied by the DI and WLC was found significant at $p < 0.05$ using a z-test of two population proportions. This implies that the DI was a more effective teaching strategy than the WLC in the remediation of logical errors committed by students in mathematics.

The observed effectiveness of the DI over the WLC and lecture method in the remediation of the different categories of process errors may have been due to the guided practice provided for by DI. This situation allowed the teacher to direct, offer necessary guidance and supervises students' activities during practice. According to Aguele (2004), the supervision of students' activities has large impact on their overall acquisition and improvement of basic skills.

The DI also has provision for independent practice during which students were given opportunity to practice with a variety of problems that could lead to mastery of the skill being taught. This is in agreement with Otto and Mcmenemy (1983) that in remediation, success is reinforced through variety of activities, pupils' involvement and repetitive practice that is necessary for mastery. This is also in agreement with Payne and Squibb (1990) that the probability of choosing a correct rule to solve a given problem is determined by the frequency of use in the past. This underscores the need for repetitive practice in any content that the students are taught in the classroom.

Results of data analysis also revealed that neither the sex of the students nor the location of their school had any influence on the effectiveness of the DI or WLC. Results of data analysis further revealed that there was no significant interaction effect of teaching strategy, gender and school location on the remediation of aggregate process errors committed by students. This implied that the effectiveness of DI and WLC on the remediation of process errors committed by students in mathematics were not sensitive to the sex of students and the location of schools (urban or rural). In other words, so long as the teaching strategies provide equal opportunities for the students, regardless of their sex or the location of their school, students' performances are likely to be the same. This agrees with Akinyemi (cited in Onwuegbu 1998). Kpangban and Onwuegbu (1995) and Onwuegbu (1998) discuss some of the factors that influence the effectiveness of teaching strategies in the classroom. In their discussion sex and location of school were never factors of consideration. Factors enumerated by them were the teacher, the students' likes and dislikes, interests and values. To this extent, the finding that there was no significant interaction effect of teaching strategy, sex and school location may therefore be in order.

CONCLUSION

Based on the findings of the study, the following conclusions were made. Firstly, it was observed that direct instruction and Wilson's learning cycle were both effective in the remediation of process errors committed by students in mathematics. However, the direct instruction appears to have been more effective than the Wilson's learning cycle.

Secondly direct instruction appears to have been more effective than the Wilson's learning cycle in the remediation of the different categories of process errors. These process errors were conceptual, translation and applied errors.

The study further revealed that no sex appeared to have benefited more than the other from any of the teaching strategies (direct instruction, Wilson's learning cycle and the control) in the remediation of process errors committed by students in mathematics.

Lastly the location of school, whether urban or rural, does not seem to have any influence on the effectiveness of any of the teaching strategies employed in the study. This is an indication that if both strategies are used effectively in urban and rural areas they are likely to produce the same results.

RECOMMENDATIONS

Following the findings of the study, the following recommendations were made. Firstly, we recommend the appropriate use of instructional strategy in adherence to remedial programme. This requires that teachers should therefore be retrained on the effective way of undertaking remedial programmes either through seminar or workshops.

Remediation should be seen as an ongoing process during normal class instruction. In this wise teachers should therefore be encouraged to use such teaching strategies like the ones used in this study, which would allow remedial activities be carried out during normal class lessons as errors are observed.

Furthermore, students should be given enough practice activities during mathematics lessons that may enhance their mastery of content being taught. Such activities should be properly supervised by teachers so that it does not degenerate into mere play. During such practice the teacher should give assistance that would help the students to overcome any initial difficulty they may have.

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