
EFFECT OF PROGRAMMED INSTRUCTION PACKAGE ON SECONDARY STUDENTS' MATHEMATICS ANXIETY AND ACHIEVEMENT IN BENUE STATE

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Abstract: *The study investigated the effects of programmed instruction package (PIP) on secondary school students' mathematics anxiety and achievement in Benue State. The study adopted a pre-test, post-test, non-randomized quasi experimental design. Two research questions and three hypotheses were formulated to guide the study. The sample size for the study was 101 JSS 1 students. Two research instruments; the Mathematics Anxiety Rating Scales (MARS) and a Mathematics Achievement Test (MAT) were used to collect data for study. The data collected were analysed using mean and standard deviation to answer the research questions and ANCOVA to test the hypotheses. The results show that PIP was effective in reducing mathematics anxiety and improving mathematics achievement. Based on the findings of the study it was recommended among other things that mathematics teachers should use PIS that reduce students' mathematics anxiety, provide better understanding and improve achievement in mathematics.*

Keywords: *Programmed Instruction Package; Anxiety; Achievement.*

Introduction

It has been established worldwide that mathematics anxiety is prevalent among students at all levels of education (Effandi & Norazah, 2008). Mathematics anxiety may lead to students' low scores on mathematics achievement tests, avoidance of enrolment on advanced mathematics courses or other courses requiring mathematics knowledge and skills as engineering, economics, the sciences and technology. Effandi and Narazah (2008) asserted that, some students with high levels of mathematics anxiety may drop out of school if intervention instruction strategies are not provided. In view of the importance of mathematics in all human activities and study, Mathematics anxiety may have a negative influence on individual's survival and hence national development. Mathematics anxiety can be defined as an emotional reaction from an individual revealing itself in feelings of uneasiness, fear or dread, mild apprehension and foreboding when faced with mathematics tasks that are difficult (Tapia, 2004). The individual may find it difficult to escape from such a situation. Kundu and Tutoo (2010) asserted that the characteristic of fear or dread and apprehension are learned by virtue of painful experiences or having been startled or overwhelmed. They add that anxiety is accompanied by a feeling of helplessness in that the individual feels blocked and finds it difficult to reason out a solution to a problem. This is more so in mathematics learning which deals with abstract concepts with specific skills and procedures in problem solving. Many factors may be responsible for mathematics anxiety in students.

Factors responsible for students' mathematics anxiety include truancy, poor preparation and learning mathematics through drill without understanding: (Norwood, 1994) & Levine, (1995) identified painful experience with mathematics over some years through primary, secondary and tertiary levels of education; teaching methodologies and lack of confidence. American Task Force on Learning Process (2008) identified potential causes of mathematics anxiety to include low aptitude, low working memory capacity, vulnerability to public embarrassment and negative parental attitude. It was observed that most of these causative factors relate to classroom situation of which the mathematics teacher can do much to change for better mathematics achievement by students. The Task Force Group, therefore, recommended research that can assess the potential causes of mathematics anxiety of students or develop desirable interventional strategies that can reduce the debilitating mathematics anxiety. In line with the recommendations of the Task Force Group, the researchers herein adopted the option of reducing students' mathematics anxiety and enhancing mathematics achievement through programmed instruction strategy (PIP) irrespective of the potential causes. This is because education is not an event but a process.

Research evidence indicates that interventions such as behavioral therapies have been successful in reducing students' mathematics anxiety with achievement scores approaching normal range. For example Hembrec (1990) in a meta-analysis, found that therapies that focus on reducing frequency of intrusive thoughts in the course of performing mathematics tasks have been successful in reducing mathematics anxiety and improving achievement. However, reports also indicate that not all treatments are equally effective, research findings reported by Geary, Boykin, Embretson, Reyna, Stegler, and Siegler (2008) indicate that individual or group counseling techniques have been relatively ineffective in reducing mathematics anxiety and improving achievement. In response to the above findings Effendi and Norazah (2008) argue that treatment of mathematics anxiety should include student's basic competencies, knowledge and skills. Student basic mathematics competencies, knowledge and skills can only be achieved through appropriate mathematics teaching strategies or approaches that are student centered. The reviewed evidence of interventions does not focus on teaching strategies such as PIP. Thus the researchers sought to fill in the gap by experimenting with PIP as a student centered teaching strategy that may strengthen students' mathematics basic competencies, knowledge and skills and subsequently reduce student mathematics anxiety and improve achievement. Programmed instruction strategy is a teaching strategy that provides student with self learning packages without or with a minimum of the teachers' guidance (Adesoji & Ifamuyima, 2007). Programmed instruction package are involved for their ability to provide student with stimuli, immediate feedback and self-testing. According to Jenkins and Keefe (2001) in (Adesoji & Ifamuyima, 2007).self – instruction focuses on the needs, talents, learning styles, interests and academic background of learners to grow and advance in mathematics knowledge and skills (Bryness, 2003). The above belief associated with PIP motivated the researchers to see whether PIS would reduce students' mathematics anxiety and improve achievement. Thus the materials in this study were

arranged in a linearly, step by step order that leads students from known principles and procedures to the unknown and from simple to complex concepts within the same context of the mathematics learning packages. PIS is one of self learning strategies that may help students to learn mathematics with confidence, reduce mathematics anxiety and enhance mathematics achievement. Several research studies have been carried out to investigate the effectiveness of programmed instruction strategy on students' academic achievement in mathematics. For example, Ajiboye (1996), Ajelabli (1998, Popoola (2002) among others reported that PIS was more effective in improving student's achievement in mathematics than the conventional method of teaching. This could be because PIS has the potential of reducing students' mathematics anxiety and enhancing their performance. However, earlier results of Smith (1996) and Watkins (1991) found no significant difference in the students' learning outcomes between those taught using PIS and those taught using conventional method. Based on the inconsistency regarding effectiveness of PIS in improving students' mathematics achievement, and/or reducing mathematics anxiety that this study becomes necessary.

Considering research on the effect of PIP on reducing students' mathematics anxiety and enhancing mathematics achievement is scanty. However, Ifandi and Norazah (2008) carried out a study on effects of motivation on student' mathematics anxiety and achievement. Ifandi and Norazah using ANCOVA to analyse, the data reported that the mean difference of the mathematics achievement of low, moderate and high mathematics anxiety students was significant. On the other hand comparison of the mean scores of low and moderate anxiety and between moderate and high anxiety groups provided insignificant results. On the effect of motivation which is one of the characteristics of PIS Ifandi and Norazah (2008) reported that the mean scores of low, moderate and high mathematics student's anxiety were significantly which implies that as mathematics anxiety increases student's achievement becomes low and vice versa. The finding of Tapila (2004); Hambree (1990); and Skiba (1990) and Brain and David (2003) also indicate that intervention effect on student's mathematics anxiety was significant. The data analysed showed that the students with low mathematics anxiety scoring higher than those with moderate and high mathematics anxiety. Also students with moderate mathematics anxiety scored higher than those with high mathematics anxiety after treatment. However, Ma (1999) and Woodard (2004) found no relationship between mathematics anxiety and achievement among the level of anxiety after treatment. It is recalled that not all interventions are always effective.

It will be noted that research reports on the effects of PIP students' mathematics anxiety is scanty especially in Benue State, Nigeria. The researchers sought to fill in this gap. In Nigeria as elsewhere teachers including mathematics teachers still believe that the only way to cover the mathematics syllabus and prepare students for external examinations is employing conventional methods of teaching especially the lecture method (Kolawole & Oluwatayo, 2005). The conventional method of teaching which emphasizes practice and drill without students' understanding is not yielding very good results (Becker & Jacob,

2002). This implies that the balance of understanding and motivation resulting in painful experience of failure could be one of the sources of students' mathematics anxiety due to the dominance of conventional methods of teaching especially in the mathematics classrooms. The above reports are supported by examination bodies as the West African Examination Council, Chief Examiner's Reports, for decades of mass failure in mathematics. Thus as mathematics educators there is need to experiment with the different methods of instruction as interventions to arrest this ugly situation. Here the researchers sought to help students in reducing their mathematics anxiety and improving performance through PIS. This research work will therefore be useful to mathematics teachers since it will throw more light on experiments with student centered approaches to help students learn mathematics meaningfully. Students too will realize the need for self learning which results to gains in confidence in mathematics learning, mathematics competencies, knowledge and skills for meaningful mathematics achievement. Curriculum planners may equally see the need of re-structuring curriculum materials to make mathematics learning for success to reach most mathematics students.

Statement of the Problem

Research works including those of Becker and Jacob (2002) and Kolamole and Oluwatayo (2005) and are replete with evidence that the conventional method of teaching is not doing enough to help students achieve highly in mathematic examinations. Students' poor achievement in mathematics has been attributed to students' mathematics anxiety to the predominance of conventional teaching methods in the mathematics classrooms (Brynes, 2003). The implication is that Nigeria's desire for scientific and technological development which rests mostly on mathematics knowledge and skills of the citizenry may not be fully achieved. The teachers' role is always at the centre of success of students in the teaching learning process for all subjects including mathematics. Thus as the implementer of mathematics curriculum, the mathematics teacher mediates between students' learning difficulties and success. This role manifests in teaching methods employed by mathematics teachers. PIP has been experimented upon considering mathematics anxiety and achievement in other places but no such study has been carried out in Benue State, Nigeria. This study therefore sought to determine the effect of PIP on students' mathematics anxiety and students' achievement. Thus the problem of this study was whether PIP could help reduce students' mathematics anxiety and improve their mathematics achievement.

Research Questions

To carry out this study the following research questions were posed.

- (i) What is the effect of PIS on students' mathematics anxiety.
- (ii) What is the effect of PIS on mathematics anxiety levels of students' achievement.

Research Hypotheses

The following hypotheses were formulated for the study.

- (1) There is no significant difference on the effect of PIP on students with low, moderate and high mathematics anxiety.
- (2) There is no significant effect of PIP on mathematics achievement of students with low, moderate and high mathematics anxiety levels.
- (3) There is no significant difference in the effect of PIP on mathematics achievement between low, moderate and high levels of students' mathematics anxiety.

Methodology

Research Design

The researchers adopted pre-test, post-test, non randomized quasi experimental design. This design was considered appropriate since intact classes were used for the study.

Population of the Study

The population of the study was made up of all junior secondary one (Jss1) students in educational zone B, Benue State. The zone has a total of 46 secondary schools with the total of 2109 JSS1 students (Benue State Ministry of Education 2013).

Sample

Two schools were purposively selected out of 46 schools. The selected schools were Government Secondary School Guma with 48 JSS1 students. The second school was St. Joseph Secondary School Makurdi with 53 JSS1 students. The JSS1 students were selected for it is at this level that the students start building their basic mathematics competencies, knowledge and skills for meaningful mathematics learning and achievement. Two mathematics graduate teachers, one from each school, facilitated the study.

Research Instrument

Two research instruments were used for the study, namely Mathematics Anxiety Rating Scales (MARS) adopted from Sherman and Wither (2003). MARS was used to rate students' anxiety levels of low (60-100), moderate (40-59) and high (0-39). Students were asked to respond to one of the items in line with the topic in the Nigerian curriculum for JSS1 for mathematics. For example relating to operations on fractions students were to respond to the following items, operation on fraction:-

Does not worry me; Worries me a little, Worries me a fair amount, Worries me a lot Worries me an awful lot (Sherman & Wither, 2003). Responses to the items were weighted as Strongly Agree (4 points) Agree (3 points) disagree (2 points) and strongly Disagree (1 point). MARS was made up of 25 items. The second instrument was Mathematics Achievement Test (MAT). MAT was a 20 item objective test lasting for 30 minutes. Mathematics curriculum coverage for JSS 1 as simple equations, fractions, estimation, among others were used. The MAT was used for pre-test on student of low, moderate and high mathematics anxiety levels before treatment. After treatment, MAT was administered in the same vein. However, the post-test was made up of similar mathematics problems in the pre-test MAT to avoid test sensitivity.

The MAT instrument was developed by the researchers and validated by two experts in mathematics education and one expert in measurement and evaluation with the Departments of science education and Department of Educational Foundations, University of Agriculture, Makurdi. Forty students of Ogiri-Oko Secondary School were used for testing the reliability of MAT. The students of Ogiri Oko secondary were not participants in the treatment. The reliability was tested using split-half method; Split-half method was performed for its ability to take care of test sensitivity of the students. The reliability of MAT was established using pears on product moment correlation coefficient. This yielded $r=0.72$.

The researchers also prepared programmed instructional materials which the two participating teachers, (one from each of the two selected schools) used as a guide. This was necessary for the participating teachers to have a uniform, style of presentation. The lesson notes as guides to the participation of teachers was based on Crowder (1960) intrinsic or branching programmed instruction strategy the branching strategy was adopted for its ability to ensure flexibility and to take care of students previous individual experiences. The treatment lasted for four weeks after which the post-test was administered on the students of all mathematics anxiety levels. The data collected after treatment was analysed using mean (\bar{x}) and standard deviations (SD) to answer the research questions. The research hypotheses were tested using Analysis of co-variance (ANCOVA) and mean difference.

Results

The results from this study were as presented below.

Research Question 1

What is the effect of PIP on students' mathematics anxiety levels? Table 1 provides the answer to this equations.

Table 1 : Mean (\bar{x}) and SD of Pre-Test, Post-Test Effect of PIP on Students' Mathematics Anxiety Scores

Anxiety Level	N	Pre-Test		Post-Test	
		Mean	SD	Mean	SD
Low	34	68.731	4.761	68.192	4.938
Moderate	36	60.098	2.939	56.011	2.724
High	31	40.506	3.927	33.402	4.556

Table 1 shows that PIP was effective in reducing students' mathematics anxiety with anxiety scores dropping from 68.731 to 68.192 ; 60.098 to 56.011 and 40.506 to 33.402 for the low, moderate and high mathematics anxiety levels respectively.

Hypothesis

There is no significant effect of PIP on students mathematics anxiety levels Table 2 presents the test of hypothesis

Table 2: ANCOVA Test of the Effect of PIP on Students Mathematics Anxiety Level (Low, Moderate and High)

Source	Type III sum of Squares	df	Mean Squares	F	Significance
Corrected model	33392.985	5	5565.498	56.555	.001
Intercept	3997.214	1	3997.214	40.619	.001
Pre-test	269.279	2	269.297	2.736	.102
Treatment	941.612	1	941.612	9.568	.003
Levels	1148.100	2	574.050	5.833	.004
Treatment levels	610.204	2	305.102	3.100	.050
Error	8758.348	95			
Total	310968.000	101			
Corrected Total	42151.333	100			

R.Squared= 792 (Adjusted R. Squared =778)

Table 2 reveals that PIP has significant effect on students with low, moderate and high mathematics anxiety. This is indicated by ANCOVA value, $F(1,100) = 9.568$; with $P=0.003, P<0.05$. Hence the null hypothesis which states that there is no significant effect of PIS on student's level of mathematics anxiety is rejected. This implies that there is a significant effect of PIS on students' level of mathematics anxiety.

Research Question 2

What is the effect of PIP on mathematics achievement of students with low moderate and high mathematics anxiety? This question is answered by table 3

Table 3: Effect of PIP on Low, Moderate and High Anxiety Students' Achievement in Mathematics

Anxiety level	N	Pre-test		Post test	
		Mean	SD	Mean	SD
Low	34	69.269	5.579	76.90	7.634
Moderate	36	64.185	4.364	70.13	5.484
High	31	47.610	3.859	42.27	11.089

Table 3 reveals the effect of PIS on students's low, moderate and high anxiety levels mathematics achievement. The students with low and moderate anxiety levels moved from mathematics mean achievement scores of 69.269 in the pre-test to 76.90 (Post-test) and 64185 to 7013 respectively. However students with high mathematics anxiety declined from a mean score of 47.610 in the pre-test to 42.27 in the post test. This shows that PIS had a negative effect on students with high mathematics anxiety.

Hypothesis 2

There is no significant effect of PIP on mathematics achievement of students with low, moderate and high mathematics anxiety. Table 4 tests the hypothesis

Table 4: Post Test ANCOVA-Test of Effect of PIP on Mathematics Achievement of Students with Low, Moderate and Higher Mathematics Anxiety

Source	Type III sum of squares	df	Mean squares	F	Significant
Corrected model	22079.104	5	4415.821	76.085	.001
Intercept	32776.608	1	32776.606	5646.142	.001
Anxiety	18903.783	2	8451.892	145.589	.001
Group	3255.163	1	3255.163	56.072	.001
Anxiety Group	463.196	2	231.598	3.989	.022
Error	5515.054	95	58.053		
Total	362734.000	101			
Corrected total	27594.156	100			

R. Squared = .800; Adjusted R. Squared = .790

Table 4 shows that PIP had effect on mathematics achievement of students with low, moderate and high mathematics anxiety. This is represented by $F(1,100) = 56,072$, $P = 001$ and $P < .05$. Hence the hypothesis which states that there is no significant effect of PIP on low, moderate and high students mathematics anxiety is not accepted. That is there is a significant effect of PIP on mathematics achievement of students with low, moderate and high mathematics anxiety.

Hypothesis 3

There is no significant difference in mathematics achievement scores of students with low, moderate and high mathematics anxiety. This hypothesis is tested in Table 5.

Table 5: Post-test Mean Difference on Mathematics Achievement among Students with Low, Moderate and High Mathematics Anxiety Levels.

Anxiety Level (i)	(j) Anxiety levels	Mean Diff (i - j)	SD	Significant at 0.05
Low	Moderate	71.213	3.861	.068
	High	37.987	10.585	.001
Moderate	Low	-7.213	3.861	.068
	High	30.774	9.431	.002
High	Low	-37.987	10.855	.001
	Moderate	-30.774	9.431	.002

Table 5 shows that the mathematics mean score difference between the low and moderate mathematics anxiety students' achievement of 7.213. $P = .068$; $P > .05$ is not significant. However the table further reveals that there is a significant difference in the mean achievement scores between students with moderate and high, low and high mathematics achievement scores with mean difference of 30.774, $P = .002$, $P < .05$ and mean difference of 37.987, $P = .001$, $P < .05$ respectively.

Discussion

The study investigated the effect of programmed instruction strategy on secondary students' mathematics anxiety and achievement in Benue State Nigeria. The data analysis

was focused on the effect of PIS on secondary students with low, moderate and high mathematics anxiety as well as their mathematics achievement.

It was discovered that there is a significant effect of PIS on students' levels of mathematics anxiety. Specifically it was found that with treatment students mathematics anxiety dropped considerably. This finding agrees with those of Hembree (1990) and Ifandi and Norazah (2008) who found that therapies aimed at reducing mathematics anxiety were successful. The results also showed that PIS has a significant effect on the mathematics achievement of students with low, moderate and high mathematics anxiety. This finding agrees with the findings of Ifandi and Norazah (2008), Hembree(1990) and Brian and David (2003). This could be due to the fact that PIS has the potential of motivating students to learn mathematics with confidence, hence reducing mathematics anxiety to improve on their performance, Mathematics teachers must engage students in problem solving strategies that reduce mathematics anxiety, provide better understanding of concepts and skills as PIS.

The study also sought to determine whether there would be a mean difference in the mathematics achievement between low, moderate and high anxiety students. It was found that the difference in the mathematics achievement scores between low and moderate was not significant. However, the mean score difference between high and moderate and low mathematics anxiety students was significant. This finding too agrees with that of Ifandi and Norazah (2008) who found that students with low, moderate and high mathematics anxiety has improved on their mathematics mean scores after intervention. The implication of these findings is that for secondary students to improve on their mathematics performance, mathematics teachers must engage students in problem solving strategies that may reduce mathematics anxiety, provide better understanding of mathematics concepts, gain confidence and acquire mathematics skills as PIS.

Recommendation

From the foregoing discussion based on the findings of this study, it is therefore recommended that mathematics teachers should use PIS more frequently than teacher centered conventional methods of teaching. The researchers of this study do not hold on PIS as the only way out. Other teaching strategies as autonomous and collaborative teaching learning strategies could be experimented with and if found effective, could be used in mathematics classrooms to reduce students' mathematics anxiety and enhance achievement.

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