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Effect of Two Psychological Techniques in Improving Academic Performance of Secondary School Students in Mathematics

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Abstract: Poor academic performance of students in mathematics has been of great concern to educationists, researchers, parents and teachers and calls for a concerted effort at remediation. To determine the efficacy of goal-setting and cognitive restructuring in improving the academic performance of secondary school students in mathematics. The design was a pre-test, post-test control group quasi-experimental design. The sample consisted of 120 students aged 15-18 years purposively sampled from a randomly selected co-educational public secondary school in Ilorin metropolis. Participants were randomly assigned to three experimental groups: Cognitive restructuring (treatment groups) and Control programme (placebo). A validated Mathematics Ability Test (MAT) was administered to the three groups before and after the experimental programme which was packaged into 8 weekly workshop sessions. Analysis of covariance with Scheffe post-hoc measure were employed for the data analysis. When the treatment group was compared with the control group in an attempt to treat analysis, there were significant differences in the mathematics performance ability of the three groups. Those in the treatment groups reported improved mathematics performance ability than their counterparts in the control group. Lack of behavioural effect on the control group could be linked to differential quality of delivery of intervention. The treatment gain was however not mediated by participants' gender. Both male and female students benefited maximally from the intervention programmes. The result is an indication that students' mathematical ability can be improved using psychological strategies and these should be factored in secondary school mathematics curriculum.

Key words: Goal-setting, mathematics, cognitive restructuring, academic performance, students, intervention strategies, Nigeria

INTRODUCTION

The need for individuals, irrespective of race or cultural affiliation to acquire the knowledge of mathematics cannot be under estimated, given its multidimensional values in every facet off human endeavours. Mathematics could be regarded as the mirror of civilization because of its practical, utilitarian, cultural, social, moral, aesthetic and recreational values. For instance, one can sometimes get on well without learning how to read and write but may never pull on without learning how to count and engage in calculations involving addition, subtraction, multiplication and division of numbers or money. Further, any person ignorant of mathematics will be at the mercy of others and will be easily cheated.

The functional role of mathematics can be observed in social institutions like banks co-operatives, railways, post offices, insurance companies, industries, transports and navigation. Other areas of its utilization include: character formation like objective analysis of complex situations, correct reasoning, valid conclusion and impartial judgment. Assim, Essien and Bassey see mathematics as a technological base required for technological transformation of the country in an era of globalisation.

Further, the relevance of mathematics among other school subjects was stressed by Bakare who regarded the overall academic performance of a student who scored very high grades in other subjects but failed mathematics as poor at West African School Certificate Examinations.

In spite of the numerous importance of mathematics, George and Thomaskutty reported that most mathematics classrooms are boring in schools either because students hate or fear the subject. This plight is partly attributed to the teachers and the rest to the curriculum. This is because neither the teacher nor the syllabus points out

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Table 1: Enrolment and achievement of students in Senior school certificate examinations, 2004-2006

Years	Total entry	Total sat (%)	Pass at credit level (A1-C6)	Ordinary pass (P7-P8)	Fail (F9)
2004	1040117	1023102	373955	334907	314240
		98.36%	36.55	32.73	30.71
2005	925288	908235	309409	308369	308369
		98.15	34.06	33.95	31.98
2006	1170523	1149277	472674	357325	286826
		98.18	41.12	31.09	24.95

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Table 2: Frequency count and percentage of students that passed at credit level in Trivandam School in India

Subjects	No. of students that passed	Pass (%)
English	9	27.3
Language -1	27	81.8
Language -2	24	72.7
General science	18	54.5
Social studies	22	66.7
Mathematics	6	18.2

the practical use of the prescribed portions which prevent students from getting interest to study the subject. Obioma and Ohuche found low performance of students in mathematics as a result of poor classroom teaching and students' attitude to school. The interdisciplinary importance of mathematics is ascertained in the fact that many topics in most engineering curricula are taught using mathematics and mathematical models. In other words, the knowledge of mathematics is imperative for students to learn and understand engineering topics. By implication, deficiencies in students' mathematics background could be major impediment to learning and my cause high attrition rate of prospective student engineers.

Also, Asim, Bassey and Essien in their trend analysis of students' achievement in Senior School Certificate Examinations (SSCE) 1999-2003 reported a slight increase from 21.91% pass at credit level in 1999 to 36% in 2003 which relatively is low because it is <50% of the number that sat for the examinations in the years under consideration.

In the same vain, the annual report of students' achievement by West African Examination Council from 2004-2006 is shown in Table 1.

The analysis in Table 1 shows that only few students with credit pass in mathematics are elegible to study science-related courses in institution of higher learning. This is a slight for a country like Nigeria aspiring for technological break through.

The submission of Asim, Bassey and Essien indicated that the inability of some students to have a credit pass in mathematics has led to frustration and has also led some opting to study other courses that does not require much knowledge of mathematics.

Investigative studies have identified different factors responsible for students' poor achievement in mathematics. Ale attributed poor achievement of students in mathematical sciences and applications to methods of training employed by teachers who are to handle the teaching of the subject.

The kind of training received by a teacher could have influence on his/her quality of teaching in the learning environment. For instance, Onwuakpa, Williams and Ben examined the influence of classroom learning environment on performance of secondary school students in mathematics. In the study, 1,200 secondary school students participated. The descriptive analyses employed showed that classroom learning environment had influence on the performance of the students.

In the same vain, Oyedeji investigated the validity of students' perseverance, study habit and self-concept in predicting their performance in mathematics. One hundred and thirty students participated in the study. Self Concept Inventory (SCI), Study Habits Inventory (SHI), Perseverance Questionnaire (PQ) and Mathematics Performance Test (MPT) were used as research instruments. The analysed data showed that self-concept perseverance and study Habit contribute 0.8, 2 and 24.4%, respectively to the variance in mathematics performance of the participants with only study habit having a statistically significant value ($F = 12.775$ and beyond $q<0.1$). This implies that students have not adequately developed a well planned and deliberated pattern of study towards understanding and passing mathematics at examinations.

The trend of poor academic performance in mathematics by students appears a global issue. To corroborate this observation; George and Theomaskutty did a survey study in a government school in Trivandrum in India. Thirty three students were interviewed on problems they face in studying mathematics. In addition, the frequency counts and percentage of number of students that pass in all the subjects for their last term examinations were also computed.

The response of the students in the interview was that they are not interested in studying mathematics. Further, the analysis of the students' performance in their last term examinations is in Table 2.

Table 2 shows that the least percentage is in mathematics. In comparing the percentage pass in General Science (54.5%) with the percentage pass in Mathematics (18.2%) means that 36.3% of the General Science students

could not make through in mathematics. This call for the need to broaden the skill and interest of the students in mathematics as it appears relevant to the learners in their various subjects or disciplines. The purpose of this study therefore is to use goal-setting and cognitive restructuring intervention techniques to improve academic performance of secondary school students in mathematics.

According to Kreitner and Kinicki (1992), most successful people have one thing in common and that is that their lives are goal-oriented. Lock (1968) conceptualized a goal as what an individual is trying to accomplish. Goals are actions put in place to achieve the expected results. They are immediate regulators of human actions. Goals are like compass that gives direction. In other words, goals help in channelling human behaviour towards the accomplishment of a mission. With a focus on what one wants to achieve, goal-setting helps in avoiding distractions. Several studies have established the effectiveness of goal-setting in psychological and educational studies. Schunk (1985), for example found that participation in goal-setting by the sixth graders enhances achievement outcomes. Other studies have confirmed the usability and fruitfulness of goal-setting (Schunk, 1990; Zimmerman *et al*., 1992; Shubshun and Alexander, 2000).

Cognitive restructuring is the second variable in this study. Cognitive restructuring is an insight behavioural procedure that emphasises recognising and changing negative thoughts and maladaptive beliefs. Cognitive restructuring is based on the assumption that cognitions are the major determinants of how we feel and act (Beck, 1979). As one thinks, so shall he/she act. This is the basic assumption among cognitive therapists (Meichenbaum, 1977; Ellis, 1982).

Assumptions students make about their ability in mathematics predisposes them to success or failure in the subject. Rigidly held assumptions restrict the flow of information thereby reinforcing counter productive behavioural patterns. Thus, cognitively oriented therapists attend primarily to how clients think about their problems. Interventions are aimed at changing thoughts, cognitive structures and ways of processing information often to promote more effective problem solving.

The purpose of the present study is to use goal-setting and cognitive restructuring (independent variables) to improve academic performance of secondary school students in mathematics. Consequently, it is hypothesized that there will be no significant treatment effect on participants' academic performance in mathematics and treatment will not be influenced by gender.

Design: The study employed pre-test, post-test experimental control group design in which the treatment (at three levels) was crossed with gender at two levels.

Participants: Participants were 120 SSS1 students drawn from a randomly selected secondary school in Ilorin Metropolis.

Instrumentation: Mathematics Ability Test (MAT) was constructed by the researchers for the purpose of finding out the extent of mathematics knowledge among the students. The scale consists of two sections. Section A deals with demographic data of the participants while Section B consists of 10 mathematics questions. A high score indicates no problem while a low score is an indication of low mathematical ability. Construct validity was used to establish the validity of the instrument yielding a standard Alpha of 0.86. The instrument was administered at both the pre-test and post-test stages.

Intervention: Goal-setting treatment was administered on participants in Group 1 while cognitive restructuring principles were administered on participants in Group 2. The programme was executed through series of lectures; discussions; role-play; hypothetical case studies for analysis and take-home assignments. The experimental programme was designed in such a way that the contents and assignments of an earlier session oriented participants to the next.

The lectures were arranged in such a way that one lecture built on the next. The opening remark oriented participants to the entire programme. This facilitated participants' appraisal of their current status vis-à-vis the new knowledge they were receiving. The experimental programme was packaged into 8 weekly workshop sessions, each session lasting for 1 h.

Data analysis: The post-test MAT scores were subjected to analysis of covariance using the pre-test scores as covariates. A Scheffe post-hoc measure was also used.

RESULTS

Table 3 shows data from the analysis of covariance of MAT scores using pre-test scores as covariates. Table 3 shows the significant effect of treatment ($F_{2, 119} = 23.87$, $p = 0.05$). However, there was no significant main effect of gender. It was also noted that there was no two way interaction of treatment and gender ($F_{2, 119} = 1.15$; $p = 0.05$). The Multiple Classification Analysis (MCA) in Table 4 reveals that cognitive restructuring group had the highest adjusted mean score of 210.00 followed by

Table 3: Summary of analysis of covariance of MAT scores by treatment and gender

Source of variance	Sum of squares	Df	Mean squares	F	Sig. of F
Covariates	7404.368	1	7404.368	24.541	0.000
	7404.368	1	7404.368	24.541	0.000
Main effects	14430.461	3	4810.154	15.943	0.000
Treatments	14406.090	2	7203.050	23.874	0.000*
Gender	24.363	1	24.363	0.081	0.777
2-Way	692.666	2	346.333	1.148	0.321
Interactions	692.666	2	346.333	1.148	0.321
Gender x	22527.495	6	3754.583	12.444	0.000
Treatment explained	-	113	301.717	-	-
Residual	34093.000	-	-	-	-
Total	56621.467	119	475.811	-	-

*Significant, $p<0.05$

Table 4: Multiple classification analysis of mathematics improvement performance scores by treatment groups and gender

Variable+Category	N	Unadjusted deviation	ETA	Adjusted for independent+covariates	Beta
Ex. groups					
Goal-setting	40	9.73	0.57	7.67	0.52
Cog. restruct.	40	17.59	-	8.21	-
Control group	40	17.59	-	-15.89	-
Gender					
Male	84	0.61	0.04	0.01	0.01
Female	36	-1.43	-	-0.24	
Multiple R^2	-	-	-	-	0.386
Multiple R	-	-	-	-	0.621

Table 5: Scheffee multiple range comparison of treatment groups' mean scores on mathematics improvement performance

Mean	Experimental groups
182.675	Control group
208.125	Goal setting*
210.000	Cognitive restructuring*

*Pairs of group significantly different at $p \leq 0.05$

goal setting group with 208.13 and finally the control group with 182.68. Therefore, the direction of increasing effect of intervention strategies (treatment) on mathematics improvement behaviour scores is CG<GS< CR.

The MCA reveals a multiple R^2 value of 0.386 and beta values of 0.52 for treatment and 0.01 for gender. The result from post-hoc analysis (Table 5) reveals that the mathematics performance scores of participants treated with cognitive restructuring is significantly higher than those of control group while participants in the goal setting group also recorded a significantly higher mathematics improvement performance than those of the control group.

DISCUSSION

The results in Table 3 and 4 show that there was significant difference in the mathematics improvement performance of treated and untreated participants. Participants in the treatment conditions outclassed their counterparts in the control group on the criterion measure. One probable explanation for the significant enhancement of the mathematics performance of the treated groups may be found in the degree of motivation to acquire some basic mathematics improvement skills which they hitherto lacked due to the fact they were not exposed to such skills while in school. While this explanation appears persuasive and plausible, it is important to note that the superior post-treatment gain of participants in the intervention conditions cannot be divorced from the effectiveness of the two strategies manipulated in the study.

This assertion is reinforced when it is realized that in an intervention study, it is possible for treatment not to have effect on criterion measure. The possible explanation for the effectiveness of the treatment packages could be attributed to the contents of the treatment packages which included a period of didactic teaching on goal-setting and cognitive restructuring procedures. Participants were trained on how to sharpen their thinking and avoid erroneous thoughts about mathematics by constant disputation, use of Elli's A-B-C paradigm, thought-stopping and humour. The treatment groups were also exposed to group discussions, practical demonstration and a weekly take home assignment for improved mathematical ability. These procedures could have helped them in looking inwards to tap the latent inert positive resources in them for optimal performance in mathematics.

The influence of gender on academic performance has been trailed with controversies. The findings of this study showed that there was no significant gender effect on the mathematics improvement ability of the participants thus

confirming the observation made by Ajogbeje (1999) that demographic characteristics are nonsense variables in terms of competence in mathematics. In other words, both male and female can benefit maximally when exposed to the same experimental condition as was the case in this study.

The control group received no skill training. This probably explains why their performance was low when compared with those in the treatment groups. The result is in line with the research findings of Okeke (2005) who investigated the effectiveness of six-thinking hats on academic performance of students in English language. Participants were 80 Junior Secondary School II students who were assigned randomly to the two groups. The treatment achieved superior gains at post test with the waiting-list control group.

CONCLUSION

The effectiveness of goal-setting and cognitive restructuring techniques in fostering academic performance of students in mathematics has added to the available counselling-oriented approaches designed to foster academic performance of students in mathematics.

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