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Effect of Instruction in Metacognitive Skills on Mathematics Test Anxiety and Interest of Low-Achieving Students in Senior Secondary Schools

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ABSTRACT

The study investigates the effect of Instruction in Metacognitive skills on Mathematics test anxiety and interest of mathematics low achieving students. Four hypotheses guided the study and a quasi- experimental pretest-postest non-equivalent control groups design was adopted. The sample consisted of 129 SSII mathematics low-achieving students in four Senior Secondary Schools in Kogi State, Nigeria. The instruments for data collection were Mathematics Interest Inventory (MII) and Mathematics Test Anxiety Scale (MTAS). Analysis of Covariance (ANCOVA) was used to test the hypothesis at 0.05 levels of significance. Findings show that instruction in metacognitive skill enhanced mathematics interest and reduced the test anxiety of mathematics low-achieving students more than those in the control group. There was no significant interaction effect (P<0.05) of instruction in metacognitive skills and gender on mathematics low-achieving students interest and test anxiety in mathematics.

KEYWORDS : metacognition, low achieving, interest, test anxiety, mathematics

Introduction

Mathematics is a core and compulsory subject for all secondary school students in Nigeria. It is a body of knowledge that deals with quantity, structure, size and space. It has been described as the key that unlocks the mystery of the subjects that shape and enhance logical thinking with its calculative inference and deductions (Exam Ethics Project, 2002). Ikeriondu (2006) observed that mathematics offers the experience needed to develop ways of dealing with problems, not only at school but in all aspects of life. Results from mathematics examinations and tests are used as a determining factor for writing report cards as well as promotion of students. Most universities in Nigeria insist on a pass in mathematics as a prerequisite for admission into any course of study or a credit pass for any science related course (Joint Admission and Matriculation Board, 2008). The emphasis on mathematics examination results and the abstract nature of the subject seems to make many students experience test anxiety before, during even after the examinations.

Secondary school continuous assessment records in most states in Nigeria have shown a consistent high failure rate in Mathematics for some years. The West Africa Examination Council (WAEC) Chief Examiner's Report further shows evidence of poor mathematics achievement. For instance, in 2007, only 25% of the total population of 1,275,330 candidates that sat for May/June WAEC passed at credit level in mathematics. In 2008, only 25.54% of the population who sat for West African School Certificate Examination obtained credit and above in English language, Mathematics and three other subjects (WAEC Chief Examiners' Report 2007 and 2008). The failure rate seems to be more among those with history of low achievement in mathematics (Umaru, 2010; Ezeahurukwe, 2010).

Low mathematics achieving students are those whose achievements are consistently very low and who in spite of efforts to cope may be quite slow, confused and lack confidence in their ability to succeed (Okebukola 1994). They are those whose achievements are consistently below average, and who have difficulties solving mathematics related problems. Concerned observers in education have suggested some reasons for the poor achievement of low achieving mathematics students such as poor teaching methods, test anxiety and lack of interest in the subject by the candidates arising from consistent poor performance (Exams Ethics Project, 2002). Experience has shown that many students who record low achievement in mathematics show aversion for mathematics and mathematics related subjects. For some of them, mere seeing the figures or the mention of the subject scares them away. Research findings support this view that low achieving students experience a higher level of test anxiety than the high achieving students (Khalid & Hasan, 2009).

Recent studies in Nigeria show that most low achieving students do not have effective study strategy that could improve achievement, sustain interest and reduce test anxiety (Eze, 2007). Instead, they adopt rote learning methods which have been found to be ineffective for learning complex tasks. Efforts have been made at improving the achievement of low mathematics achieving students including the use of learning strategies such as elaborative interrogation, advance organizers, concept mapping and group activity strategies (Okebukola, 1994; and Idowu, 2002). Studies on these methods have focused mainly on determining their efficacy on facilitating achievement across subject areas. Enough attention seems not to have been paid to the effect of these constructivist strategies in reducing test anxiety and increasing interest in mathematics . Mathematics is a subject that requires problem solving and metacognitive strategies to equip learners with skills in problem solving thereby enabling the learners to assume responsibility for their own learning. When learners take charge of their own learning, they develop confidence in themselves and pursue learning with greater vigour (Schoenfeld, 2008). This study therefore focuses on determining the efficacy of metacognitive skills on the test anxiety and interest of low achieving mathematics students.

Metacognition

Metacognition is a high order thinking which involves an active control over the cognitive processes learners engage in while studying (Livingstone, 2004). It refers to learners' automatic awareness of their own knowledge and their ability to understand, control and manipulate their cognitive processes (Kuhn, 1995). Flavell (1979) described metacognition as one's knowledge concerning one's own cognitive processes and the active monitoring and regulation of the processes. Knowledge about cognition refers to the level of the learners understanding of his/her own memories, cognitive system and the way he/she learns to regulate his/her own learning system, that is, goal setting, choosing, applying strategies and monitoring his/ her action. These definitions emphasize the executive role of metacognition in overseeing and regulating cognitive processes. Executive control processes are those processes responsible for the processing of information, selection of actions, and the implementation and monitoring of task (Flavell, 1999). Metacognition has provided educators an insight into the cognitive processes involved in learning and what differentiates successful students from their less successful peers. Successful students have been suggested to apply metacognitive skills in pursuing learning much more than less successful ones.

Metacognitive skills involve activities such as planning how to approach a given learning task, monitoring comprehension and evaluating progress towards the completion of a task. In a study,

Test Anxiety

Test anxiety is a psychological construct which breeds uneasiness, worry and tension especially before, during and after an examination or a testing situation. According to Olatoye and Afuwape, (2003) test anxiety is the psychological condition of a person, expressed by the degree of concern, dread, ambiguity, distress and vulnerability shown before taking an examination, during an examination or after an examination. Stober (2004) found that test anxiety can be conceptualized as a situation-specific trait, with a disposition to react with heightened anxiety in the face of examination or test situations. Students who go through test anxiety are characterized by increased heart beat, racing thoughts, difficulty concentrating, remembering answers to questions after taking the examination, nausea, cramps, sweating, headache and dry mouth.

Research has shown that test anxiety decreases student's academic achievement (Woolfolk (2005); DordiNejad, Hakuni, Ashouri, Dehghani,. Zeinali, Daghighi, & Bahrami, (2011). In a study conducted by Md Yasin, Dzulkifli (2009) on the differences in the test anxiety of low and high achieving students in Malaysia. The findings indicate that there were significant differences between low and high achieving students in their psychological problems such as test anxiety. Yousefi, Redzuan, Mansor, Juhari, & Talib, (2010) in their study examined the effect of test anxiety on memory using 400 high school students in Iran. The findings indicate that test anxiety affects students' memory, motivation and students' ability to pay attention and these could invariably affect students' academic performance.

Woolfolk (2005) noted that anxiety affects learning at three major points- focussing attention, learning and testing. He noted that anxious students may be worried about a learning task such that they may not concentrate to learn the task. Sometimes when they pay attention they find it difficult learning a task that is disorganized and/or difficult. The highly anxious students also have poor study habits and for such students simply learning to relax may not solve their problem. The students may also lack critical test taking skills which may make them to forget what they know during examinations. This study sought to determine the effect of instruction in the use of metacognitive skills on students' test anxiety.

Interest

Elliot, Kratochwill, Littlefield and Travers (2000) defined interest, as an enduring characteristic expressed by a relationship between a person and a particular activity or object. In this sense interest is a source of motivation. According to Hurlock as cited in Ngwoke (2005), interests drive people to do what they are free to choose. When people see that something will benefit them, they become interested in it. Studies have shown that learners develop competence and efficiency in areas or subjects they have interest (George, 2006; Miner & Lauri (2008). In activities like counting, subtraction, addition and multiplication in mathematics, interest leads one to learn more from the task. Interest adds enjoyment and makes the performance of activity or task more economical in terms of demand on limited cognitive resources. The interest students show in an activity or in an area of knowledge predicts how much they will attend to it (Papalia, Old and Feldman, 2002).

Interest occurs when a student's needs, capacities and skills are good match for the demand offered by a particular activity (Deci, 1992). Invariably students' interest in an activity predicts how much they will attend to it and how well they will process, comprehend and remember the task. Students interest in a task increases when they feel competent to do the task and when they experience success. Interest therefore motivates one to learn and to make effort and when success is experienced interest in the activity increases. The effect of instruction in metacognition skills on the interest in mathematics of low achieving students was a question for consideration in this study

Another factor that seems to affect the academic achievement of students is gender. Evidence has shown that studies on gender as a factor in mathematics achievement have focused mainly on such variable as gender stereotype in training and assessment, and that very few studies have investigated how gender interacts with skills needed for mathematics achievement (Omirin, 2005). Betiku (2002) in a study reported that gender differences in the achievements of students (boys and girls) in Science, Technology and Mathematics (STM) show a line of difference in favour of boys. Some other research studies show evidence of girls' superiority over boys in mathematics (David, Lay, and Kay 1987). These findings show inconsistencies on gender differences in mathematics achievement. This study may therefore, contribute significantly to the unresolved controversy on gender factor in mathematics achievement of the students. Research has further shown that there are gender differences in test anxiety. Butt, Akram, Gulzar, Yahya (2013) found that females show higher significant level of test anxiety than males. Other researches indicate that there is no gender difference in test anxiety (Everson & Millsap, 1991; Mwamwenda, 1993).

Theoretical Basis

The study adopted Flavell's theory of metacognitive development. Flavell (1979) defined the components of metacognition by creating a model of cognitive monitoring/regulation. The proposal involves four components involving metacognitive knowledge, metacognitive experiences, goals or tasks and actions or strategies. The ability of the learner to control a wide variety of cognitive enterprises is dependent on the actions and interactions among the various components. Flavell states that metacognitive knowledge consists primarily of knowledge or beliefs about what factors or variables act and interact in order to affect the course and outcome of cognitive enterprises. He identified three categories of these factors namely person variable, task variable and strategy variable. The person variable addresses everything that one can come to believe about the nature of oneself and others as a cognitive processor. The task variable refers to the information available and the demands of a given cognitive task the individual is involved in. It gives credence to the way information is presented, the goal to be achieved and the path one will follow to manage the given task so as to achieve the set goal. The strategy variable deals with the strategies that will be effective in achieving the set goal.

Regulation of cognition refers to metacognitive activities that help control one's thinking or learning. Three essential regulatory skills according to Woolfolk (2005) include planning, monitoring and evaluation. Planning involves the selection of appropriate strategies and the allocation of resources that affect performance. Monitoring is the ability to engage in periodic self-testing while learning while evaluation refers to appraising the products and regulatory processes of ones learning. It also involves re-evaluating one's goals and conclusion. The Flavell theory therefore, explains the process that engendered metacognitive skills development that ensures the learner will be able to construct meaning from information. To accomplish this, the learner must be able to think about their thought processes and identify the learning skills that work best for them and consciously manage how they learn.

Hypotheses

This study was guided by the following null hypotheses that were tested at 0.05 levels of significance

H_{01} : Instruction in metacognitive skills has no significant effect on low achieving students' interest in mathematics as measured by their mean scores on the Mathematics Interest Inventory (MII)

H_{02} : Instruction in metacognitive skills has no significant effect on test anxiety of low mathematics achieving students as measured by their mean scores on the Mathematics Test Anxiety Scale (MTAS)

H_{03}: There was no significant interaction effect of instruction in metacognitive skills and gender on interest in mathematics scores of low mathematics achieving students as measured by MII

H_{04} : There was no significant interaction effect of instruction in metacognitive skills and gender on test anxiety scores of low mathematics achieving students as measured by MTAS

Method

Design of the Study

A quasi-experimental research design was used for the study. The design was specifically the pre-test post-test non-equivalent control group design with one treatment group and one control group. This was considered appropriate because full experimental control was lacking as random assignment of subjects to treatment and control

groups was not done.

Area of the Study
The study was carried out in Kabbah Education Zone in Kogi State of Nigeria. The choice of the study area was based on the Ministry of Education's Report, (2010) that many students from Kabba education zone in Kogi State perform poorly in mathematics every year in spite of efforts to reverse the trend.

Population of the Study
The population of this study consists of 4,776 low achieving senior secondary class two students in all the senior secondary schools in Kabbah education zone of Kogi State. The choice of senior secondary class two (SSII) students was guided by the assumption that the students have attained the formal operational stage of cognitive development. At this stage students can be taught new kinds of thinking, which are abstract, formal and logical. Thinking symbolically at this stage is necessary if one should be able to deal with the mathematical problems solved at their level of education.

Sample and Sampling Technique
The sample for this study consists of 129 identified low achieving senior secondary class two (SSII) mathematics students. They were drawn from four co-educational senior secondary schools in the education zone that were purposively selected based on their record of poor achievement in mathematics. In each school, one intact class was randomly selected. The identified low achieving mathematics students in the four intact classes constituted the sample used for the study. The low achieving mathematics students were identified based on teachers' nomination as well as their performance on previous assessment records in mathematics. All the students who consistently scored below 50 percent in their continuous assessment since they entered senior secondary were identified as low achieving mathematics students. The researcher randomly assigned two schools as the treatment group and the other two as control group.

Instrument for the Study
Two instruments were constructed and used for the study. They are Mathematics Interest Inventory (MII) and Mathematics Test Anxiety Scale (MTAS). MII and MTAS instruments are four point rating scales designed to measure students' interest and test anxiety in mathematics. The rating scales range from Very High Extent (4), High Extent (3), Moderate Extent (2) to Low Extent (1). The items of the instruments were developed based on relevant information gathered through review of literature. The items statements were written in a manner that can be comprehensible and easy to rate by the respondents. Negative item statements were reverse scored.

Validation of the Instruments
The MII and MTAS were face validated by two specialists each in educational psychology, measurement and evaluation, mathematics and special education for their criticism and inputs. They were asked to check for the clarity of the language and also check if the instruments were measuring what they were supposed to measure. The inputs of these specialists were used to modify and improve the instruments.

Reliability of the Instruments
The instruments (MII and MTAS) were trial tested using 20 SS II students drawn from a co-educational secondary school in Nsukka Local Government Area. The internal consistency reliability estimates of the instruments were determined based on the result of the trial testings. The internal consistency reliability was determined using the Cronbach alpha method and the reliability estimates of 0.92 and 0.87 were obtained for MII and MTAS respectively. In order to determine the stability of MII and MTAS over time, a test retest analysis using Pearson correlation method was conducted and a Pearson r of 0.83 and 0.82 were obtained respectively for MII and MTAS. This was necessary since the items in the MII and MTAS were reshuffled and used for the post-test.

Development of Metacognitive Instructional Programme
The researchers developed an instructional programme with the help of experts in special education and educational Psychology. The instructional programme was developed based on the information gathered from literature. The purpose is to develop an instructional programme that will facilitate the teaching of metacognitive skills. In developing this instructional programme, the researcher identified and stated in behavioural terms the objectives to be achieved, the activities of the instructor and the subjects, the instructional materials, strategies and the evaluation techniques to be utilized. The instructional programme was designed to last for a period of six weeks and each session lasted for thirty five minutes.

Validation of the Instructional Programmes
The instructional programme was face validated by two experts in special Education and Educational Psychology. The objectives, activities, evaluation techniques, time limits and the number of sessions were provided to serve as a guide for their comments. The suggestions of the peer reviewers were used to restructure and improve the programme.

Trial Testing
The face validated metacognitive instructional programme was trial tested by the researchers with the help of two trained research assistants. The instructional programmes were used in instructing the low mathematics achievers in a SSII in Nsukka Local government Area. The aim was to ensure that the programme will be adequate in achieving the objectives of the study. It was also done to ensure that the training programme was clear enough and well understood for easy implementation.

Treatment Procedure
Before the actual implementation of the programme, the schools selected were assigned randomly to experimental and control school. Thereafter in each school selected, one class of SS II was randomly selected for the study. In each class selected, all students in the class was involved in the treatment but only assessment results or data from those identified as low achieving was used in the study. The researchers were not involved in the teaching rather two qualified mathematics teachers were trained as research assistants. One taught in the two treatment schools while the other taught in the two control schools.

Metacognitive skills instructional programme was used in training the subjects in the treatment groups. Those in the treatment group received instruction in metacognitive skills of monitoring, regulating / revising and evaluation using examples from mathematics contents. All these were done through the following methods; Modeling by a trained teacher, Coaching through offering such help as hints, feedback, reminders while the students were at work, Scaffolding by offering support in the form of suggestion and Reflections in which students compare their process with those of an expert. The control group were only exposed to the normal mathematics lesson based on the selected mathematics content for the study. The students in the experimental and control groups were taught the selected mathematics concepts in their normal class setting. After the teaching, the reshuffled MII and MTAS which served as a post test were administered to the students two weeks after.

Method of Data Analysis
The data collected were analysed descriptively using mean scores and standard deviations and Analysis of Covariance was (ANCOVA) used to test the null hypotheses at 0.05 levels of significance.

Results
What is the difference in the mean mathematics interest scores of students exposed to instruction in metacognitive skills and those who were not exposed?

Table I: Pre-test and Post-test Mean Scores and Standard Deviations on Mathematics Interest Inventory MII

Mathematics Interest Inventory		Pre-interest	Post-interest	Mean gain score
Treatment	Mean	38.7188	58.1406	19.42
	N	64	64	
	SD	5.45245	8.31115	
Control	Mean	38.3846	41.0615	2.68
	N	65	65	
	SD	4.45004	8.26680	

Data presented on Table 1 above indicate the pre-test and post-test mean achievement score of the students in the treatment and control groups. The low – achieving mathematic students taught using instruction in metacognitive skills had a pre-test score of 36.72 with a standard deviation of 5.45 and a post-test of 58.14 with a standard deviation of 8.31. The pre-test and post-test mean mathematics interest gain score is 19.42. The control group had a pre-test score of 38.38 with a standard deviation of 4.45 and a post – test mean score of 41.06 with standard deviation 8.27. The pre test and post-test mathematics interest mean gain score is 2.68. This indicated that those exposed to instruction in metacognitive skill had more interest in mathematics and performed better than those not exposed to instruction in metacognitive skills.

$H0_1$: Instructions in Metacognitive skills has no significant effect on students' interest as measured by the mean score in MII

Table 2: Summary of 2 – Way Analysis of Covariance (ANCOVA) on the Low – Achieving mathematics Students' Interest

Source	Sum of Square	Df	Mean Square	F	Sig.	decision at 0.05 level
Experimental	8682.872	1	8682.872	137.099	.000	S
Gender	232.946	1	232.946	3.678	.057	NS
Experimental *Gender	11.842	1	11.842	.187	.666	NS
Error	7853.387	124	63.334			

R Squared = .567 (Adjusted R Squared = .553)

The data presented in Table 2 above showed that treatment involving training in metacognitive skills as a main factor had a significant effect on the mathematics interest score of the low – achieving mathematics students. The F-value of 232.946 was significant at .000 levels and also at .05 levels of significance. This suggested that the null hypothesis of no significant differences in the mean mathematics interest scores of students taught using instruction in Metacognitive skills and those not exposed to it was rejected. In other words, there was a significant difference in the mean students' interest score in mathematics of the two groups in favor of these exposed to instruction in metacognitive skills. The Adjusted R squared of 0.553 further suggested that 55% of the total variance on the dependent measure was contributed by treatment using instruction in Metacognitive skills. This evidence showed that instruction in Metacognitive skills was effective in enhancing the mathematics interest of the students in experimental group as compared to those in the control group.

What is the difference in the mean mathematics test anxiety scores of students exposed to instruction in metacognitive skills and those who were not exposed?

Table 3: Pre-test and Post-test Mean Scores and Standard Deviations on Mathematics Test Anxiety Scale MTAS

Mathematics Test Anxiety Scale		Pre-Anxiety	Post-Anxiety	Mean gain score
Treatment	Mean	75.34	63.82	-11.52
	N	64	64	
	SD	8.81	6.28	
Control	Mean	68.83	66.26	-2.61
	N	65	65	
	SD	11.24	11.54	

Data on Table 3 indicate that the low – achieving mathematics students taught using instruction in metacognitive skills had a pre-test score of 75.34 on the test anxiety scale with a standard deviation of 8.81 and a post-test mean score of 63.82 with a standard deviation of 6.28. The pre-test and post-test mean mathematics test anxiety gain score is -11.52. The control group on the other hand had a pre-test score of 68.83 with a standard deviation of 11.24 on the scale and a post-test mean score of 66.26 with standard deviation of 11.54. The pre test and post-test mathematics test anxiety mean gain score is -2.68. This implies that those exposed to instruction in metacognitive skill had a higher reduction in mathematics test anxiety scores than those that were not exposed to instruction in metacognitive skills.

H_{o2} : Instruction in metacognitive skills has no significant effect on test anxiety of low achieving mathematics students as measured by their mean scores on (MTAS)

Table 4: Summary of 2 – Way Analysis of Covariance (ANCOVA) of the Low – Achieving mathematics Students on their Mathematics Test Anxiety Scale (MTAS)

Source	Type III Sum of Square	Df	Mean Square	F	Sig.	decision at 0.05 level
Experimental	1864.363	1	1964.363	18.479	.000	S
Gender	158.681	1	158.681	1.474	.227	NS
Experimental *Gender	.803	1	.803	.008	.931	NS
Error	13181.577	124	106.303			

R Squared = .181 (Adjusted R Squared = .154)

The data presented in Table 4 above showed that treatment involving instruction in metacognitive skills as main factor had a significant effect on the mathematics test anxiety of the low – achieving mathematics students. The F-value of 18.479 in respect of treatment as main effect was significant at 0.000 levels and also at 0.05 levels of significance. This suggested that the null hypothesis of no significant difference in the mathematics test anxiety of students taught mathematics using instruction in metacognitive skills was rejected. In other words, there was a significant difference in the students' test anxiety in mathematics of the two groups in favor of these exposed to instruction in metacognitive skills. The Adjusted R squared of 0.154 further suggested that 15% of the total variance on the dependent measure was contributed by treatment using instruction in metacognitive skills. The evidence of this study showed that instruction in metacognitive skills was effective in reducing the mathematics test anxiety of the students in treatment groups as compared to those in the control group.

HO_3: There is no significant interaction of treatment and gender on the mathematics interest scores of low achieving students in mathematics as measured by mean scores on MIS

Data on Table 2 above indicate that the interaction of treatment and gender on the mathematics interest of low – achieving students as measured by their mean scores on MIS was not significant at 0.05 levels of significance. This is shown by the observed f- value of .187 which was significant at .666 but not significant at .05 levels of probability. The null hypothesis of no significant interaction of treatment and gender on mathematics interest scores of the low achieving students in mathematics was therefore not rejected. This implies that both gender benefited consistently from the metacognitive instruction.

HO4 : There is no significant interaction of treatment and gender on the mathematics test anxiety scores of low achieving students in mathematics as measured by mean scores on MTAS

Data on Table 4 above indicate that the interaction of treatment and gender on the mathematics test anxiety of low – achieving students as measured by their mean scores on MTAS was not significant at 0.05 levels of significance. This is shown by the observed f- value of .008 which was significant at .931 but not significant at .05 levels of probability. The null hypothesis of no significant interaction of treatment and gender on mathematics test anxiety scores of the low achieving students in mathematics was therefore not rejected. This implies that both gender benefited consistently from the metacognitive instruction.

Discussion of Results

The findings of the study were discussed in line with the research questions and hypotheses raised in the study.

Effect of Instruction in Metacognitive Skills on Mathematics Interest and Test Anxiety of Mathematics Low-Achieving Students

The results of this study showed that teaching mathematics to low achieving mathematics learners adopting metacognitive strategies enhanced their interest and reduced test anxiety in mathematics. The low achieving mathematics learners who received instruction in planning, monitoring, regulation/reflection and evaluation had a significantly higher in interest in mathematics and reduced test anxiety than those in the control group.

The finding of this study is in line with the findings of George (2006), Miner and Lauri (2008) who found that students developed more competence in subjects that they are interested in. Thus the interest students showed in an activity/area of knowledge predicts how much they would attend to it; and how well they process, comprehend and remember it (Deci, 1992; Papalia, Old & Feldman, 2002). The demonstrated interest in mathematics of low achieving mathematics learners could have been as a result of successful learning of skills in using task specific strategies, self regulating the use of the strategies and assessing the importance of the activities and their usefulness. When the instructors explicitly demonstrate and model the skills involved and explains the task specific strategies and how to self regulate and monitor, they provide information that learners can adopt in guiding practice in situations that are useful for meaningful learning. Acquisition of these skills transfers the responsibility of learning to the learner and as such could promote self-efficacy belief, interest in learning and reduced test anxiety. Heightened test anxiety and reduced interest in a subject usually result from consistent failure. Therefore, when performance consistently improves as a result of acquisition of learning skills, interest grows with the awareness that one can control his/her own learning and this also could possibly reduce test anxiety.

Interaction Effects of Treatment and Gender on Mathematics Interest and Test Anxiety of Low-Achieving Students in Mathematics

The results of this study also indicated that male and female low achieving mathematics students in the experimental group had higher interest mean scores and higher reduction in test anxiety mean scores than the low achieving mathematics students in the control group. However, the interaction effect of treatment and gender as measured by their mean scores on mathematics interest and test anxiety was not significant. The null hypotheses of no significant interactions of treatment and gender on interest and test anxiety scores in mathematics of the low-achieving students were therefore not rejected. These indicated that the relative effect of instruction in metacognitive skills on interest and test anxiety were consistent across the two levels of gender suggesting that both male and female low-achieving mathematics students benefited significantly and consistently from the skills taught. These further suggest that gender is not a significant factor in applying metacognitive skills in mathematics problem solving. Instruction in metacognitive skills provided in a gender fair environment exposes males and females to opportunities in learning skills in problem solving and lifelong learning.

Conclusion

From the findings and discussion of the study, the following conclusions are made:-

Instruction in metacognitive skills helps to facilitate mathematics interest and reduce test anxiety among low achieving mathematics students.

Instruction in mathematics using metacognitive skills does not significantly affect the mathematics interest and test anxiety of **mathemat**ics low achieving male and female students.

Recommendations

On the basis of the findings of this study, the following recommendations have been made:

a). Teachers should ensure that mathematics low-achieving students should be exposed to instruction in metacognitive skills to equip them with learning skills relevant for solving problems in mathematic.

(b). Seminars, conferences and workshops should be organized on the theme: Meta-cognitive Learning Strategies. Such seminars and workshops would provide opportunities to examine critically the concept, procedure, and application of meta-cognitive approaches in learning all school subjects.

(c). Schools should learn to make teaching and learning students – centred and not teacher centred. They should ensure that students are actively involved in the learning activity by ensuring their active participation in their lessons.

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