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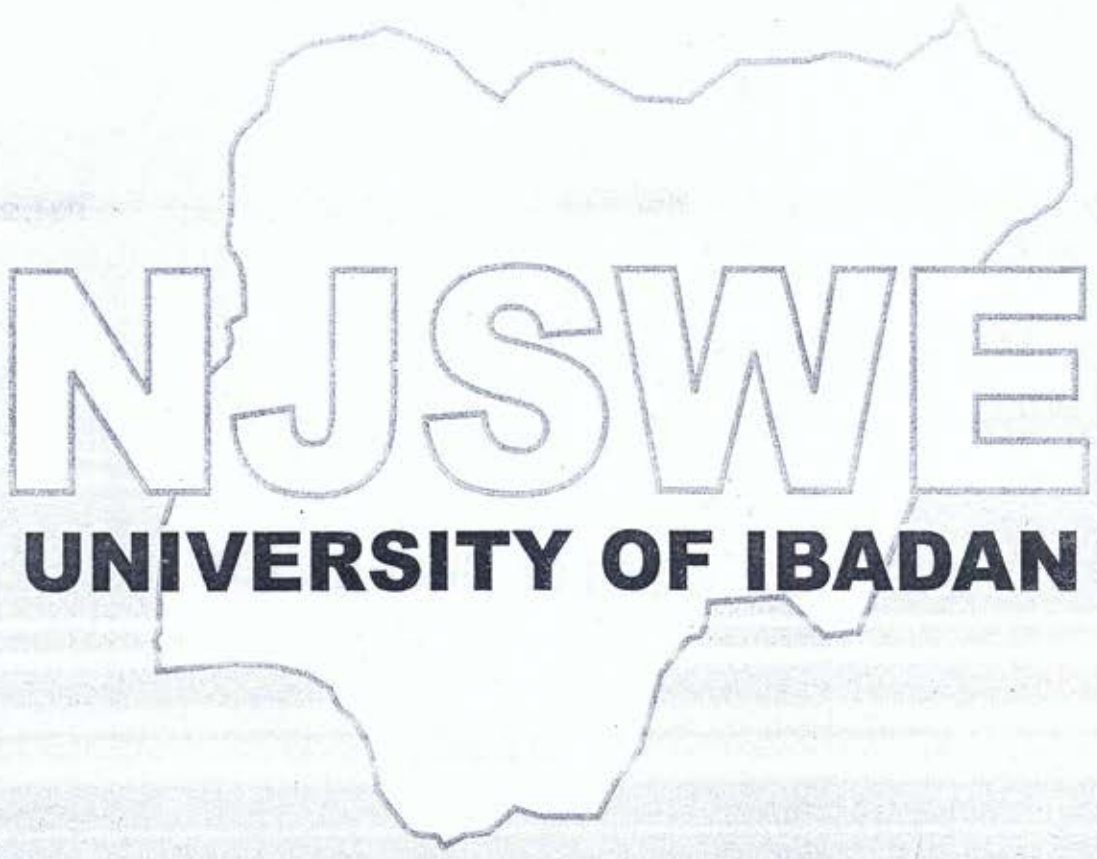

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CONTENTS

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IMPACT OF BRAIN-BASED INSTRUCTIONAL STRATEGY ON STUDENTS' ATTITUDE TO SENIOR SECONDARY SCHOOL MATHEMATICS IN OYO STATE, NIGERIA.

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Abstract
This study investigated the impact of brain-based instructional strategy on students' attitude to Senior Secondary School Mathematics. A pre-test, post-test, control group quasi-experimental design was adopted with a 2 x 3 x 2 factorial matrix. The sample was 522 Senior Secondary School II Students from nine randomly selected schools in Oyo State, Nigeria. Five schools were randomly assigned to the experimental group (Brain-Based Instructional Strategy - BBIS), while four schools were assigned to the control group (Non-Brain-Based Instructional Strategy -NBBIS). The instruments were: Mathematics Attitude Questionnaire (r = 0.83), Cognitive Style Test (r = 0.81) and Mathematics Anxiety Rating Scale (r - 0.81). One research question and one hypothesis guided the study. Data obtained from the research question were analyzed using mean scores while the hypothesis was tested at 0.05 level of significance, using the analysis of covariance (ANCOVA). Brain-based instructional strategy was more effective at improving students' attitude to Mathematics than the conventional method. Teachers of Mathematics could therefore adopt brain-based instructional strategy for teaching secondary school students.

Keywords:
Brain-based instructional strategy, Students' Attitude, Senior Secondary School Mathematics.

Introduction

Mathematics has been highly rated among other subjects, and for that reason, it has been described as the queen of all sciences and servant to all disciplines. Perhaps, it is against this basis that the Federal Government of Nigeria under the auspices of the curriculum planning body of the Federal Ministry of Education decided to make Mathematics a core (compulsory) subject. This is to help in the achievement of the national objectives of Nigeria which among other things, include the building of a united, strong and self-reliant nation and a land of great and dynamic economy (FRN, 2004). Onabanjo (1999) noted that in every branch of industry in the country, Mathematics has come to play an imperative role as a result of its wide spread application in all areas of science, technology and the economy.

In view of these lofty goals, the Federal Government of Nigeria expedited action by investing heavily (financially and materially) on education through the promotion and popularization of the study of Mathematics and science at all levels of the education system. In spite of these laudable efforts by the Federal Government since the inception of the New Policy on Education, the dividends are not commensurate with the inputs (Onwuakpa 1999).

Dada (1999), quoting Chalfant & Scheffehn (1969) remarked that Mathematics is the abstract science of space and number, which deals with space configuration and the interrelationships and abstraction of numbers. He also noted that Mathematical Education in Nigerian schools was derived from the British National Curriculum (2000) as stated thus:

> *Mathematics equips pupils with uniquely powerful tools to understand*

and change the world. These tools include logical reasoning, problem-solving skills and the ability to think in abstract ways. Mathematics is useful, in everyday life, many forms of employment, science and technology, medicine, the economy, the environment, development and in public-decision making (p. 17).

Several instructional strategies have been recommended for the teaching-learning process of Mathematics, which include the use of personalized system of instruction, (Kadiri, 2004; Ku and Sullivan, 2000); Clubs and Games (Afuwape, 2002; Aremu, 2001) combined strategy of concept mapping and problem solving (Awofala, 2000); self-regulatory and cooperative learning strategies (Ifamuyiwa, 2005; Ojo, 2003) and computer and test assisted programmed instruction (Etukudo, 2002; Uduosoro, 2000). While it is evident that these strategies are learner-centred (Ifamuyiwa, 2005; Afuwape, 2002) and are in favour of conceptual, sequential and logical aspects of Mathematics, none of them takes into consideration the function and structure of the brain. This is a gap which this study attempted to fill. Research evidence suggests that the adoption of learner-centred strategy based on the structure and function of the brain can improve learners' academic performance (Sousa, 2008; Adebayo, 2005; Lucas, 2004; Lacknewy, 2002).

Brain-Based Learning strategy is a learner-centred and teacher-facilitated strategy that utilizes learners' cognitive endowments. Sousa (2004) said a brain-based approach integrates the engagement of emotions, nutrition, enriched environments, music, movement, meaning making and the absence of threat for maximum learner's participation and achievement. Proponents of brain-based instructional strategy

(Sousa, 2004; Ryan and Abbot, 1999; Caine and Caine, 1998; Jensen, 1998) identified three instructional learning techniques of the strategy. These are:

(i) **Relaxed Alertness:** It consists of low threat and high challenge. It is the technique employed to bring the brain to a state of optimal learning,

(ii) **Orchestrated Immersion:** This is a technique of trying to eliminate fear in learners, while maintaining a highly challenging environment,

(iii) **Active Processing:** This technique allows the learners to consolidate and internalize information by actively processing it.

Brain-Based learning strategy! What is it all about? To many, the term "brain-based" learning sounds redundant and they ask such question as isn't all teaching and learning brain-based? Advocates of brain-based teaching insist that there is a difference between "brain-compatible" education and "brain-antagonistic" teaching practices and methods, which can actually impair learning.

Brain-based learning sometimes called Brain-compatible is an educational approach based on what current research in neuroscience suggests about how our brains naturally learn best (Lucas, 2004). The learning strategy derived from this research can easily be integrated into any learning environment, from a kindergarten classroom to a seminar for adult.

With new technologies that allow scientists to observe the brain functions as they occur, we are gaining insights into how the brain learns, assimilates, thinks and remembers. From these findings, an approach to education called the brain-based learning has evolved. This instructional strategy is based on the structure and functions of the brain. Lucas (2004) asserted that as long as the brain is not prohibited from fulfilling its normal

processes, learning will occur since everyone is born with a brain that functions as an immensely powerful processor. Understanding how the brain learns and relating it to the educational field resulted in the concept known as brain-based learning. It is defined as any teaching strategy that utilizes information about the human brain to organize how lessons are constructed and facilitated with emphasis placed on how the brain learns naturally.

Students' beliefs and attitudes have the potential to either facilitate or inhibit learning. Gibbons, Kimmel and O'shea (1997) opined that students' attitudes about the value of learning science may be considered as both an input and outcome variable because their attitudes towards the subject can be related to educational achievement in ways that reinforce higher or lower performance. This means that those students who do well in a subject generally have more positive attitudes towards that subject and those who have more positive attitudes towards a subject tend to perform better in that subject.

Studies have shown that test anxiety is associated with a significant performance decrement in students (Zakaria and Nordin, 2008). Greenwood (1984) stated that the principal cause of Mathematics anxiety lies in the teaching methodologies used to convey basic mathematical skills. To him, teachers create anxiety by placing too much emphasis on memorizing formulae, learning Mathematics through drill and practice, applying rote-memorized rules and setting out work in the traditional way. This study investigated through quasi-experimental design, the impact of brain-based instructional strategy on students' attitude to Senior Secondary School Mathematics in Oyo State, Nigeria.

Research Question:

What is the pretest and posttest mean scores of achievement in Mathematics scores of students exposed to Brain-Based Learning and Conventional Strategies?

Hypotheses

Based on the stated problem, the following hypotheses were generated and tested at 0.05 alpha level.

HO_1: There is no significant main effect of treatment on students' attitude towards Mathematics.

HO_2: There is no significant main effect of mathematics' anxiety on students' attitude towards Mathematics.

HO_3: There is no significant interaction effect of treatment and mathematics' anxiety on students' attitude towards Mathematics.

Method

Quasi-experimental research design was used in this study. The design consisted of two treatment groups (Brain-Based Instructional Strategy and Conventional Instructional Strategy). Moderator Variable was the Mathematics' Anxiety at three levels (low, medium and high).

In using this design, two intact classes of participants were randomly assigned to experimental and control groups respectively. Participants in each group were pre-tested on the dependent variables and thereafter exposed to different treatments. The experimental group was exposed to Brain-Based Instructional Strategy while the control group was exposed to Conventional Strategy. The participants in both groups were post-tested after the application of treatment.

Sample and sampling techniques

Five hundred and twenty-two senior secondary two students were involved in this study. Stratified random

sampling procedure was used in selecting nine schools: five of the schools were randomly assigned to experimental groups and four schools to control groups. In each of the nine sampled schools, only two randomly selected intact classes (SS II) were involved in the study.

Research Instruments

The following two instruments were used for data collection:

(i) Mathematics' Attitude Questionnaire (MAQ)

(ii) Mathematics' Anxiety Rating Scale (MARS)

Mathematics' Attitude Questionnaire (MAQ)

MAQ developed by investigators is an instrument of twenty items that elicits information from the participants on their attitude towards Mathematics. The instrument is made up of two sections A and B. Section A is designed to elicit responses in relation to student's name, age, gender, class and name of school. Section B is made up of twenty items (ten positive and ten negative statements), requesting participants to indicate their attitude towards the study of Mathematics based on a four-point modified Likert scale. Each participant was requested to tick an appropriate option weighted as follows:

Strongly Agreed (SA) - 4
Agreed (A) - 3
Disagreed (D) - 2
Strongly Disagreed (SD) - 1

This rating was meant to reflect how the participants felt about the particular statement.

Mathematics' Anxiety Rating Scale (MARS)

This is an instrument designed to determine the participants' mathematics' anxiety at three levels (low, medium or high). Mathematics' anxiety was measured through the use of an adapted version of Mathematics' Anxiety Rating Scale (MARS) developed and used by Beasley (2001) and Hopko (2003). The MARS has two sections, A and B. Section A is designed to elicit responses in relation to participants' age, gender and name of school. Section B consists of twenty items with response format on five – point scale ranging from 1 = not at all to 5 = very much. For each of the items, student is expected to indicate how much each of the items applies to him/her.

Procedure Pre-Experimental Activities

Training of Research Assistants: The researcher appointed and trained twelve research assistants on the nature and purpose of the Brain-based Instructional Materials. Essentially, the research assistants were needed in the areas of administration of pre-test and post-test, organization and arrangement of research materials.

Pre-Test Administration

The following instruments were administered as pre-test in that order before the commencement of treatment:

(i) Mathematics' Anxiety Rating Scale (MARS)
(ii) Mathematics' Attitude Questionnaire (MAQ)

Data Analysis

Data collected were analysed using descriptive and inferential statistics. Inferential Statistics of Analysis of Covariance (ANCOVA) was used to test the hypotheses and estimate the impacts of various factors on the dependent variables. The Multiple Classification Analysis (MCA) was used to determine the mean scores of students in various

groups. Scheffé post-hoc test was used to determine the source of the significance and see the direction and the amount of variations due to each independent variable.

Results and Discussion

Research Question 1: What is the pre-test and post-test mean score attitude to Mathematics scores of students exposed to Brain-Based Learning and Conventional Strategies?

Table 1: Attitude mean scores of students exposed to Brain-Based Learning and Conventional Strategies

Treatment		ATTITUDE	
		X	SD
Experimental	Pre-test	52.47	10.66
	Post-test	57.36	13.59
Control	Pre-test	54.81	15.96
	Post-test	56.13	14.87

Table 1 showed that the pre-test and post-test Mathematics' attitude scores of students in the experimental group were 52.47 and 57.35 with corresponding standard deviations of 10.66 and 13.59 while that of the control group were 54.81 and 56.13 with corresponding standard deviations of 15.96 and 14.87 respectively. The results revealed that there was an improvement in the post-test mean scores of the students in the experimental group. This indicated that treatment actually had influence on students' attitude to Mathematics in the experimental group.

Hypothesis 1
There is no significant main impact of treatment on students' attitude toward Mathematics.

Table 2 Summary of 2 x 3 x 2 ANCOVA of Post-Attitude Mean Scores of Students by Treatment, Cognitive Style and Anxiety Test Score

Source of		Experimental Method				
		Sum of	df	Mean	F	Sig. F
Covariates	Pre-Attitude	4075.624	1	4075.62	24.4	.00
Main	(Combined)	1536.373	4	384.093	2.300	.062
	Treatment	293.966	1	293.960	1.761	.18
	Mathematics	964.331	2	482.166	2.888	.06
2-Way Interact	(Combined)	2177.479	5	435.496	2.608	.027
	Treatment x	1842.945	2	921.472	5.519	.005*
Residual		86818.01	52	166.958		
Total		94718.24	52	181.453		

***Significant at p < 0.05**

Table 2 showed that there was no significant main impact of treatment on students' attitude towards Mathematics ($F_{(1, 520)} = 1.761$; $p > 0.05$). This means that the post attitude mean scores of the experimental and control groups were not significantly different at $p < 0.05$. Hence, the null hypothesis was not rejected. Table 3 showed the magnitude of the mean scores of students in the various groups in the study.

Table 3: Multiple Classification Analysis on Post Attitude Mean Scores by treatment and Mathematics' Anxiety
Grand Mean = 57.14

Variable + Category		N	Unadjusted Mean	Adjusted for Factors and	Unadjusted Deviation	Eta	Adjusted Deviation	Beta
Treatment	Experiment	281	57.69	57.84	.55	0.44	.70	3.136
	Control	242	56.50	56.33	-.64		-.81	
Mathematics' Anxiety	High	49	54.37	55.37	-2.78	.128	-1.78	10.861
	Medium	249	55.96	56.06	-1.19		-1.08	
	Low	225	59.06	58.73	1.92		1.59	
Multiple R		0.243						
Multiple R Squared		0.059						

From Table 3, the Brain-based learning group obtained the higher mathematics' attitude means score (M = 57.84) than the Control group (M = 56.33). The difference in mathematics' attitude mean score between the Brain-based learning group and the control group was however not significant. This might have contributed to the non-significant main impact of treatment recorded in this study. The table also showed that 5.9% of the variation in students' attitude toward Mathematics was accounted for by taking the independent variable (treatment) and the moderator variable (cognitive style) together.

Hypothesis 2:
There is no significant main impact of mathematics' anxiety on students' attitude towards Mathematics.

Table 2 showed that there was no significant main impact of mathematics' anxiety on students' attitude towards Mathematics ($F_{(2, 520)} = 2.89$; $p > 0.05$). This means that students with varying mathematics' anxiety did not differ significantly in attitude towards Mathematics. Hence, the null hypothesis was not rejected.

The MCA Table 3 showed the differences among the three mathematics' anxiety levels but these differences were not strong enough to bring about significant main impact on anxiety test score in students' attitude towards Mathematics. Students with high mathematics' anxiety recorded the lowest attitude mean score in Mathematics (M = 55.37), preceded by medium mathematics' anxiety group (M - 56.06) while the low anxiety test score group recorded the highest attitude mean score in Mathematics (M = 58.73).

Hypothesis 3:
There is no significant main impact of treatment and mathematics' anxiety on students' attitude towards Mathematics.

There is no significant interaction impact of treatment and mathematics' anxiety on students' attitude towards Mathematics.

Table 3 indicated that there was a significant interaction impact of treatment and mathematics' anxiety on students' attitude towards Mathematics ($F_{(2, 520)} = 5.52$; $p < 0.05$). Therefore, the null hypothesis was rejected.

Table 4 Interaction score between Treatment and Anxiety

Treatment	Anxiety		
	Low	Medium	High
Brain-Based Learning Strategy Group	59.06	55.95	54.36
Control Group	54.82	56.52	60.84

Table 4 shows that within the Brain-Based Learning Strategy group, students with low mathematics' anxiety recorded highest attitude mean score towards Mathematics (M = 59.06) followed by the medium mathematics' anxiety group (M = 54.36) while those with high mathematics' anxiety recorded the lowest attitude mean score towards Mathematics (M = 55.95). In the control group, students with highest anxiety test score recorded the highest attitude mean score towards Mathematics (M = 60.84), followed by low mathematics' anxiety group (M = 56.52) while those with medium mathematics' anxiety obtained the lowest attitude mean score towards Mathematics (M = 54.82) as shown Fig. 1.

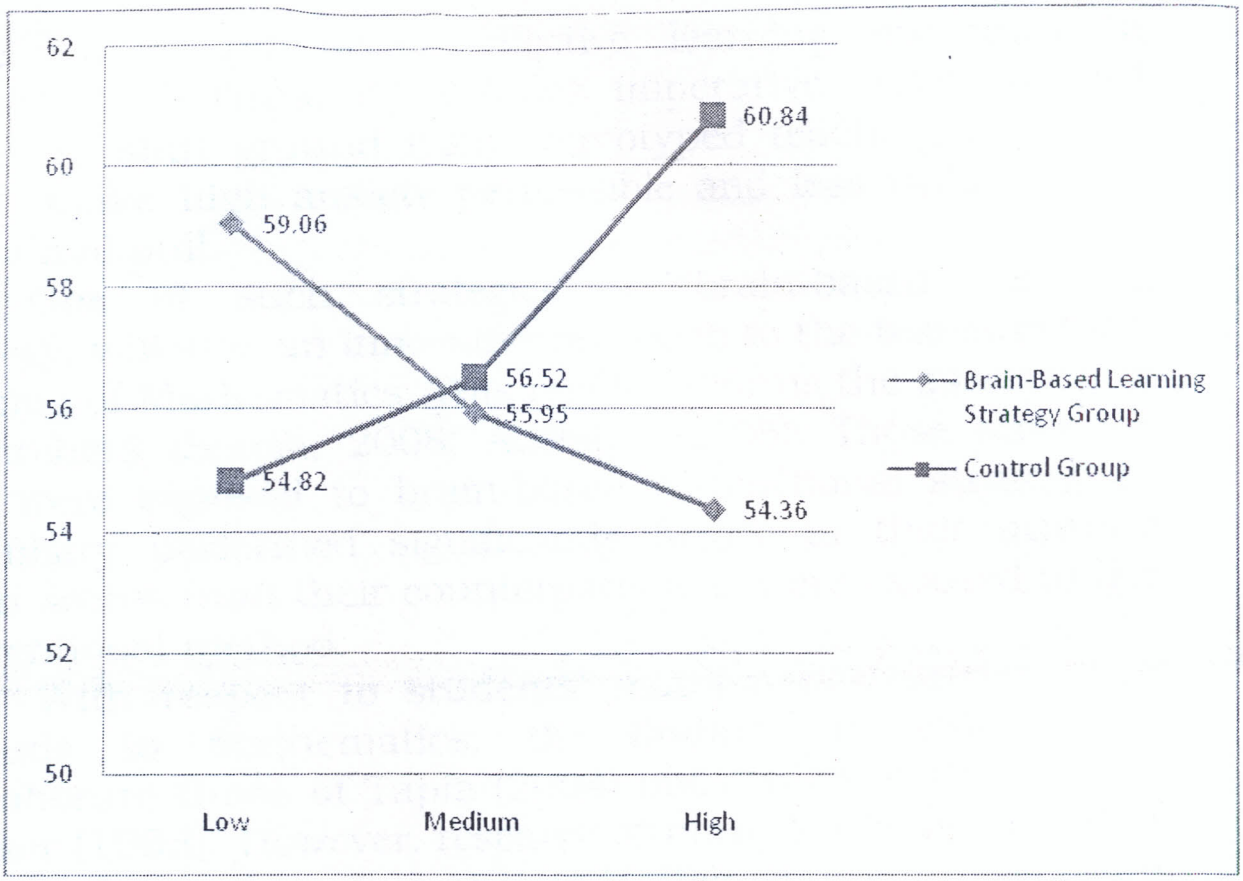

Fig. 1: Interaction Impact of Treatment and Mathematics' Anxiety on Students' Attitudes towards Mathematics

This interaction is disordinal. It means both the treatment and anxiety worked together to produce a joint impact on students' attitudes.

Discussion

The Brain-based learning group obtained higher mathematics' attitude mean scores than the Control group. The difference in mathematics' attitude mean scores between the Brain-based learning group and the control group was however, not significant. The investigators, therefore, are of the view that if brain-based instructional strategy is adopted to teach Mathematics, learners could be better improved in terms of contextual thinking, creative reasoning, logical thinking, sequential learning, intuitive knowledge and insightful learning - which are resistant to forgetting and

these would aid better affective learning outcomes in Mathematics. Thus, it becomes imperative, relevant and timely to shift ground from stereotyped teaching methods, which make high anxiety permissible and less utilization of attitudinal pull.

One of such strategies is "'brain-based" learning strategy, which is an innovative approach to the teaching, and learning of Mathematics. This result confirms the assertion of researchers (Sousa, 2008; Adebayo, 2005). Those students who were exposed to brain-based instructional strategy in Chemistry performed significantly higher in their attitude mean scores than their counterparts who were exposed to the conventional method.

With respect to students' mathematics' anxiety and attitude to Mathematics, the findings in this study corroborate those of Tapia (2004) but diverge with those of Nasser (1998). However, research studies clearly indicate that students' attitude performance in Mathematics improves when anxiety is alleviated (Ashcraft, 2002). Teachers alleviate that anxiety when they demonstrate excitement and confidence in the subject-matter, develop a relevant Mathematics curriculum, use effective instructional strategies, create classrooms centred on discovery and inquiry, and assess students in a meaningful and fair manner (Shields, 2005).

Conclusion and Recommendations

It is clear that students' attitude to Mathematics consistently relate to students' achievement in Mathematics. Therefore, to improve students' attitude in Mathematics, innovative strategy such as Brain-Based Instructional Strategy should be adopted in secondary schools. Teachers of Mathematics should endeavour to take cognizance of "prime time" during any teaching-learning process. For instance, in a 40-minute period, students' attention is strongest for the first 20 minutes, then the

brain needs "down time" for approximately 10 minutes (Brain's downshifting is like a camera that has a reduced focus). The next ten minutes is the next best teaching time. Teachers of Mathematics should be encouraged to make adequate provision of an enriched learning environment, well-designed brain-compatible instructional materials and judicious use of varied strategies in a learning episode. This would put to minimal, the alarming rate of fear, test phobia and undesirable attitude of students towards Mathematics.

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