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Impact Of Strategic Interventions In Teaching-Learning Of Mathematics In Secondary Classes: An Empirical Study

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This research study investigates the effectiveness of strategic interventions designed for experimental group of secondary school students in classes IX and X. Mathematics students prove to be significant in terms of the assessment based on a criterion test after employing strategic interventions on the experimental group while teaching the specific contents, viz. Polynomials, Quadrilaterals, Mensuration, and Trigonometry of Mathematics of classes IX and X syllabus as prescribed by Central Board of Secondary Education, New Delhi.

An experimental design was employed, with 100 students divided equally into experimental and control groups. The experimental group received instruction through a set of targeted interventions including concept-based teaching, diagrammatic support, language flexibility, peer collaboration, and formative assessments. In contrast, the control group was taught using conventional methods. Criterion achievement tests were developed and administered to assess learning outcomes.

Statistical analysis indicated that the experimental group of 50 students achieved considerably superior scores on criterion tests administered for Class IX and X through strategic interventions, compared to the control group.The control group were taught using traditional method of chalk and talk as adopted to teaching mathematics in most of the traditional classroom of mathematics wherein teachers simply solve the problems only on the black board and students copy it with or without comprehending the intricacies of the steps followed in solving the problems of mathematics. The results support the adoption of learner-centered, strategically planned teaching methods to improve mathematics achievement at the secondary level.
Keywords: Strategic intervention, mathematics education, secondary school, experimental study, criterion test, teaching-learning.

1. Introduction

Mathematics plays a critical role in developing logical reasoning, problem-solving abilities, and abstract thinking among students. However, the general practice of teaching mathematics and the traditional classroom teaching as adopted by mathematics teachers prove to be futile in terms of lacking in forming the basic concept attainment of mathematics. Every new topic

to be taught in mathematics mandates that the students must possess the previous knowledge or steps as required to learn a new topic or concept. For solving equations, students must have the attainment of the concept of solving factors and its varied steps otherwise they will be stuck in the steps of learning equations.
This article intends to find out the strategic interventions which prove to be effective in teaching mathematics to class IX and X students in Indian classrooms.

Mathematics is overviewed as cumbersome which is driven by a negative stereotypical thinking on the part of learners who find themselves detached from the subject due to lack of basic concepts of mathematics as the same overlaps with their gradual promotion to upper classes and thus gap of learning of mathematics becomes wider by the time they reach class X. Thus, the poor interest of students in the background holds the fact that students' scheme of learning lacks bonding of their previous knowledge and present teaching-learning of mathematical terms, steps and concepts of Mathematics in lower or higher classes.

2. Need of the Study

In the present study, the researcher identified such concepts which are required by the students to learn a new topic such as polynomials, quadrilaterals, mensuration and trigonometry etc.

This study is also important to make specific use of strategic interventions at different points of teaching, i.e. beginning of a new topic with questions to test the previous knowledge of the student's and also using appropriate intervention strategies at different points and steps in order to find the difference between the learning and performance of the experimental group and control group using two different methodologies.

Thus, the need of the study is justified to use strategic interventions in teaching mathematics to class IX and X students.

3. Review of Literature

A comprehensive review of literature is significant in finding out the gap of research which directly manifests that research is obligatory on such gaps of knowledge to evacuate the barriers of the respective area for addressing the problem for which research is sought to be undertaken. In the present research, the researcher has reviewed literature of such researchers conducted on teaching-learning of mathematics and challenges pertaining to teaching-learning of mathematics to students of mathematics, in general and class IX and X students, in particular.
The researcher reviewed various research with findings which are reflected herewith as summarized below:

Lumbantoruan, J. H., & Manalu, R. U. (2024), evaluated high school students' understanding of mathematics curriculum as the goal of the study. Three types of content are challenging for high school. Among the things that pupils should understand is derivative content. Students' learning objectives were, in fact, low-derived content. The infrequency with which teachers create teaching modules causes problems. Minisola, R. et al. (2024) acknowledged it as a cultural practice, and adapting it to a setting outside of Japan was a difficult task. It looked at

a teaching experiment where a group of researchers acting as didacticisms, or teacher educators, incorporated lesson study into an aspiring teacher's professional development course at an Italian university. It studied the twin roles of researcher and teacher educator using the anthropological theory of the didactic and meta-didactical transposition frameworks.

Arifin, A. et al. (2024) explored the complex connections between secondary school student academic achievement, teacher professional development, and classroom environment. The study uses a mixed methods approach that includes surveys, interviews, and focus group discussions because it recognizes the critical role these aspects play in determining educational results. Using statistical analyses like regression and structural equation modeling, the quantitative phase aims to teach about 150 students and 100 teachers. It also reveals significant positive relationships link student academic achievement and teacher professional development. Qomariyah, S., et al. (2023) determined that assessment activities were an important part of the educational system for determining how well the learning process is going. The study's findings indicate that the social essay test measures high school students' ability to solve mathematical puzzles. Nine of the items are reliable and genuine, with one eliminated (invalid). It was able to identify what is well-developed and valuable based on the research findings.

In summary, the literature shows that innovative teaching approaches, technological integration, professional development, and teacher attitudes are all important components of successful secondary mathematics teaching-learning. However, there remains a need to empirically test the effectiveness of integrated, student-centered interventions in real classroom settings. This study addresses that gap by examining the impact of a comprehensive set of strategic interventions in secondary school mathematics education.

4. Objectives of the Study

The objectives of this study specifically are as follows:

1. To study the methodology of teaching-learning of mathematics as practiced in traditional secondary class.
2. To use interventional strategies to improve the attainments of students in teaching-learning mathematics in secondary class (IX and X).

5. Hypothesis of the Study

In order to statistically evaluate the impact of the strategic interventions, the subsequent null hypotheses are formulated:

H_{01}: There is no significant difference in attainments of mathematics among class IX students taught through the traditional classroom and classroom using interventional strategies in teaching-learning of mathematics.

H_{02}: There is no significant difference in attainments of mathematics among class X students taught through the traditional classrooms and classroom using interventional strategies in teaching-learning of mathematics.

6. Methodology

This section explains how the study was conducted to test the impact of different teaching methods on students' performance in mathematics.

6.1 Research Design

This study adopted a true experimental design involving both an experimental group and a control group, each consisting of randomly selected students from secondary schools. The experimental group received instruction through a structured set of strategic interventions, while the control group continuous with traditional “chalk and talk” teaching methods. This design enabled a direct comparison of student performance between the two instructional approaches.

6.2 Strategic Interventions Implemented

The following interventions were applied to the experimental group during instruction:

- Showing and explaining the conceptual framework of the topics with an aim to attain concept of the topic.
- Presenting diagrams and using manipulative skills used in the classroom.
- Removal of language barriers in the classroom by freedom to express the terms and concepts in the student's mother tongue.
- Connectivity of the students with the topic being established as to know “Why learning of the topic is important to learners?”.
- Linear program style used to ensure that students move from one step to the other step after learning the previous step.
- Formative Assessments (Oral and Written) used in the classroom.
- Interactive classroom environment to promote peer learning and cooperative learning by the strategies.
- Problem solving approach as key to learning by the students.

6.3 Population and Sampling

The population of this study consists of all the students studying in Class IX and X enrolled in various secondary schools in the Aligarh District of Uttar Pradesh. Since the present study was a true experimental design method hence, 200 students of Class IX and X were selected randomly from the students of mathematics in selected schools only. The researcher used the strategic interventions as mentioned earlier which were regularly catered and monitored to find the accomplishment of the experimental group whereas the control group was left with the schoolteachers who used traditional methods of teaching as prevalent in the respective schools.

Therefore, the experimental group was under observation and direct monitoring of the researcher. Of course, the respective teacher at the school under study was involved in the teaching of mathematics along with the researcher for using appropriate interventional strategies as required for teaching topics as given hereinbefore for the respective classes.

6.4 Tools Used

Two self-prepared criterion-referenced tests were developed separately for classes IX and X as the tools for testing the achievement of learners after completion of teaching of the topics as pre-determined topics and respective strategies were also identified for effective teaching-learning of mathematics. Both the tools were scrutinized by subject matter experts and any ambiguous or overly difficult questions were revised or removed to ensure clarity and content validity. Finally, 15 items were selected in each of the two tools with a maximum score of 50 each for the tools used.

6.5 Data Collection and Analysis

This criterion-referenced achievement test was designed and administered to students, such items of the tool i.e., criterion test was reshuffled with the help of expert mathematics teachers at the schools earlier. The criterion test of mathematics included the topics mentioned earlier as expected from class IX and X students to possess the ability to solve such problems related to their mathematics course as prescribed by CBSE, New Delhi by the month of February. The criterion test was purposefully served in the month of February after completion of their syllabus to avoid any incomplete or untaught part of the lessons. On the pre-scheduled date and time as determined by the school, the criterion-referenced test tools were given to the students with 2 hours duration.

After 2 hours duration, the tools were collected and evaluated with marks allocation to the tools which were tabulated and analysed for the study.

The data of the experimental and control group were analysed as given below:

Criterion Test No. 1: This test was intended for class IX students, 50 of which were randomly allotted to control group and 50 to experimental group. The answer copies were evaluated and scored. The mean performance was calculated as 30.56 and 36.6 for control group and experimental group respectively.

Criterion Test No. 2: This test was intended for class X students, 50 of which were randomly allotted to control group and 50 to experimental group. The answer copies were evaluated and scored. The mean performance was calculated as 30.12 and 38.2 for control group and experimental group respectively.

Hypothesis 1 (H_{01}): There is no significant difference in attainments of mathematics among class IX class students taught through the traditional classroom and classroom using interventional strategies in teaching-learning of mathematics.

To test the hypothesis, z-test was used as below:

Group	**No. of Participants**	**Mean**	**S.D.**	**z-score**
Control	50	30.56	8.38	4.06
Experimental	50	36.6	6.36	

The data presented in the table indicates that the computed z-score of 4.06 surpasses the critical value of 2.58, which is the tabulated value at the 0.01 level of significance. This indicates a notable distinction between the two groups in class IX. The experimental group demonstrated a notable advantage over the control group in terms of performance. Consequently, null hypothesis 1 is dismissed, validating the efficacy of strategic interventions for class IX students.

Hypothesis 2 (H_{02}): There is no significant difference in attainments of mathematics among class X students taught through the traditional classroom and classroom using interventional strategies in teaching-learning of mathematics.

To test the hypothesis, z-test was used as below:

Group	**No. of Participants**	**Mean**	**S.D.**	**z-score**
Control	50	30.12	7.46	6.08
Experimental	50	38.2	4.74	

From the above table, the calculated z-score of 6.08 exceeds the critical value of 2.58, which is the tabulated value at the 0.01 level of significance. This indicates a significant difference between the two groups in class X. The experimental group demonstrated markedly superior performance relative to the control group. Consequently, null hypothesis 2 is rejected, indicating that the interventions had a positive effect on class X students.

The results indicate that students in the experimental group demonstrated superior performance compared to those in the control group in both classes IX and X, with a significant difference in their achievements. Interventional statistics were found to significantly enhance students' achievements in mathematics. This supports the conclusion that well-designed, student-centered teaching strategies can improve learning outcomes in secondary mathematics education.

Results and Analysis

To evaluate the impact of the strategic interventions, criterion-referenced tests were administered to both the experimental and control groups of classes IX and X. The mean scores and standard deviations were calculated, and z-tests were used to determine the significance of differences in performance. Results as accrued in this study give the findings that interventional strategies have proved to be effective in teaching-learning of mathematics in secondary classes.

The results of this study strongly indicate that the strategic interventions implemented in the experimental classrooms contributed to a significant improvement in students' mathematics achievement. Key findings include:

- Students in the experimental group achieved higher mean scores compared to those in the control group in both grades IX and X.
- The z-test results confirmed that these differences were statistically significant at the 0.01 level, thereby rejecting the null hypotheses.

- The interventions, which emphasized conceptual clarity, collaborative learning, language inclusivity, and formative assessments, proved effective in enhancing comprehension and problem-solving abilities.
- Traditional methods, which rely heavily on procedural teaching and minimal student interaction, were comparatively less effective in supporting student learning.

These findings imply that mathematics training that actively engages students in the learning process and contextualises concepts in relevant ways results in superior learning outcomes. Such strategies, as used in this study, have proven effective in improving students' mathematical achievement levels.

7. Conclusion

In view of the results of this research, results and interpretation of data, it can be determined that different strategic learner-centered teaching interventions significantly improve mathematics achievement among secondary school students. The eight key strategies used in this study, ranging from concept-building approaches to collaborative learning can serve as effective pedagogical tools in secondary classrooms.

Teachers should try to move beyond traditional chalk-and-talk methods by using more interactive and inclusive teaching practices. These methods help students understand mathematical concepts more clearly and keep them actively involved in learning. The outcomes of this study also support the use of modern teaching styles that encourage students to explore, ask questions, and connect new topics with what they already know. This is especially important in mathematics, where learning depends on building a strong foundation step by step.

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