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Instructional Design and Pedagogical Effectiveness in Mathematics Education

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Abstract: *The present study was conducted to examine the effectiveness of an instructional design-based mathematics teaching programme on the academic achievement of secondary school students. Mathematics is often considered a difficult subject by many learners, particularly at the secondary level, due to abstract concepts, procedural complexity, and lack of engaging teaching methods. In this context, the study aimed to investigate whether a systematically planned and pedagogically structured teaching programme could improve students' learning outcomes in mathematics. The study was carried out on a sample of 50 students of Class IX selected from a secondary school. The researcher adopted an experimental method using a one-group pre-test post-test design. A Mathematics Achievement Test was prepared and administered to the students before the implementation of the teaching programme to assess their initial level of achievement. Subsequently, a one-month instructional design-based mathematics teaching programme was implemented, focusing on learner-centered pedagogy, activity-based learning, concept clarification, guided practice, and reinforcement. After the completion of the programme, the same test was administered as a post-test. The collected data were analyzed using appropriate statistical techniques, namely Mean, Standard Deviation, and t-test. The findings of the study revealed a considerable improvement in students' mathematics achievement after the treatment. The comparison of pre-test and post-test scores indicated a statistically significant difference, confirming the effectiveness of the instructional design-based teaching programme. The study concludes that systematic instructional design and pedagogically effective teaching strategies can significantly enhance mathematics achievement among secondary school students, and therefore should be incorporated into classroom teaching practices.*
Keywords: *Instructional Design, Pedagogical Effectiveness, Mathematics Education, Secondary Students, Achievement, Experimental Study*

1. Introduction

Mathematics is a fundamental subject in school education and plays a vital role in the development of logical thinking, problem-solving ability, analytical reasoning, and decision-making skills among students. However, many secondary school students perceive

mathematics as difficult, abstract, and uninteresting. This often leads to poor academic performance, fear, and low confidence in the subject. In the modern educational context, effective mathematics teaching requires not only content delivery but also systematic planning, suitable instructional design, learner-centered pedagogy, activity-based learning, and reinforcement strategies. Instructional Design refers to the systematic process of planning, developing, implementing, and evaluating instruction to ensure effective learning outcomes. When mathematics teaching is organized through a well-designed pedagogical programme, students are more likely to understand concepts clearly and perform better academically. The present study attempts to examine the effectiveness of a mathematical teaching programme based on instructional design and pedagogy for Class IX students.

2. Need and Significance of the Study

Mathematics is often taught through conventional lecture methods, with limited student participation. Such approaches may not adequately address differences in students' learning styles, conceptual difficulties, or engagement levels. Therefore, there is a need to design and implement an instructional programme that can make mathematics teaching more effective, meaningful, and learner-centered.

This study is significant because it:

- helps identify the role of instructional design in mathematics learning,
- provides empirical evidence regarding pedagogical effectiveness,
- contributes to improvement in classroom teaching practices,
- offers guidance for mathematics teachers at the secondary level,
- supports innovative teaching strategies for better student achievement.

3. Objectives of the Study

1. To study the pre-test achievement of secondary school students in mathematics.
2. To implement an instructional design-based mathematical teaching programme for Class IX students.
3. To study the post-test achievement of secondary school students in mathematics after the teaching programme.
4. To compare the pre-test and post-test scores of students in mathematics.
5. To determine the pedagogical effectiveness of the instructional design-based mathematics teaching programme.

4. Hypotheses of the Study

Null Hypothesis (H_0):

There is no significant difference between the pre-test and post-test achievement scores of secondary school students in mathematics after the implementation of the instructional design-based teaching programme.

Alternative Hypothesis (H_1):

There is a significant difference between the pre-test and post-test achievement scores of secondary school students in mathematics after the implementation of the instructional design-based teaching programme.

5. Variables of the Study

Independent Variable: Instructional Design-based Mathematics Teaching Programme

Dependent Variable: Achievement in Mathematics

6. Limitations of the Study

The present study was limited to a sample of 50 students studying in Class IX. The research was confined to only one secondary school, and therefore the findings may not be generalized to all schools or student populations. The study focused exclusively on the subject of Mathematics and did not include any other school subjects. It was further delimited to the implementation of an instructional design-based mathematics teaching programme of one month duration. Moreover, the investigation was restricted only to the achievement aspect of students in mathematics and did not cover other related variables such as attitude, interest, motivation, aptitude, or anxiety towards mathematics.

7. Research Methodology

Method of the Study

The researcher used the Experimental Method for the present study.

Research Design

One Group Pre-Test Post-Test Design

Group	Pre-Test	Treatment	Post-Test
50 Students	Yes	One-Month Mathematics Teaching Programme	Yes

Sample & Sampling Technique

For the present study, a sample of 50 students studying in Class IX was selected from a secondary school. These students were chosen as the participants to assess the effectiveness of the instructional design-based mathematics teaching programme and to compare their achievement in mathematics before and after the treatment.

The sample for the present study was selected by using the convenient sampling method. This technique was adopted because the students were easily accessible to the researcher and suitable for the implementation of the experimental teaching programme within the available time, school setting, and research conditions.

8. Tool Used for Data Collection

The researcher used a Mathematics Achievement Test for collecting data.

Characteristics of the Test

- Based on Class IX Mathematics syllabus
- Objective and short-answer type questions
- Covered conceptual understanding, problem-solving, and application
- Used as both Pre-Test and Post-Test

9. Description of the Mathematical Teaching Programme

A one-month instructional design-based mathematics teaching programme was carefully prepared and implemented by the researcher for the students of Class IX. The programme was designed in accordance with sound pedagogical principles to make mathematics teaching more systematic, engaging, and effective. It emphasized clearly stated learning objectives, step-by-step presentation of concepts, and learner-centered classroom interaction. The teaching programme incorporated activity-based learning, the use of suitable teaching aids, relevant examples and illustrations, and opportunities for guided practice and problem-solving exercises. It also included regular revision, reinforcement, feedback, and

correction to strengthen students' conceptual understanding and skill development. Special attention was given to encouraging active learner participation throughout the teaching process. The instructional programme covered important mathematics topics prescribed at the secondary level, namely Algebraic Expressions, Linear Equations, Geometry, Mensuration, and Statistics. The entire programme was implemented over a period of one month in a planned and structured manner.

10. Procedure of the Study

The study was conducted in the following steps:

1. The researcher selected 50 students of Class IX.
2. A Pre-Test in mathematics was administered.
3. Students were taught through an instructional design-based mathematical teaching programme for one month.
4. After completion of the programme, a Post-Test was administered.
5. The obtained scores were tabulated and analyzed using Mean, Standard Deviation, and t-test.

11. Statistical Techniques Used

For the analysis and interpretation of the collected data, the researcher employed appropriate statistical techniques. The Mean was used to determine the average performance of students, Standard Deviation was used to measure the variability in scores, and the t-test was applied to test the significance of difference between pre-test and post-test scores.

12. Analysis and Interpretation of Data

Comparison of Pre-Test and Post-Test Scores of Secondary School Students in Mathematics

Test	N	Mean	SD	Mean Difference	Calculated t-value	df	Table t-value (0.01)	Significance
Pre-Test	50	41.28	8.64	27.64	19.31	49	2.68	Significant
Post-Test	50	68.92	9.15					

Interpretation

The above table shows that the Mean score of students in the Pre-Test was 41.28, whereas the Mean score in the Post-Test increased to 68.92. The Standard Deviation of the Pre-Test was 8.64 and that of the Post-Test was 9.15.

The Mean Difference between Pre-Test and Post-Test scores was found to be 27.64. The calculated t-value was 19.31, which is much higher than the table t-value of 2.68 at 0.01 level of significance with 49 degrees of freedom.

Therefore, the null hypothesis is rejected, and it is concluded that there is a significant difference between the pre-test and post-test scores of secondary school students in mathematics.

This indicates that the instructional design-based mathematical teaching programme was highly effective in improving the achievement of students.

13. Result of Hypothesis Testing

1. Since the calculated t-value (19.31) is greater than the table value (2.68) at the 0.01 level, the difference between pre-test and post-test scores is statistically significant.
2. Therefore, the null hypothesis, which stated that there is no significant difference between the pre-test and post-test scores of students, is rejected on statistical grounds.
3. It is concluded that the instructional design-based mathematics teaching programme had a significant positive effect on the achievement of secondary school students in mathematics.

14. Major Findings of the Study

1. The Pre-Test achievement of Class IX students in mathematics was found to be comparatively low.
2. The instructional design-based mathematical teaching programme was successfully implemented for one month.
3. The Post-Test achievement of students in mathematics improved considerably after the treatment.
4. The Mean score increased from 41.28 to 68.92, indicating substantial improvement.
5. The calculated t-value (19.31) showed a statistically significant difference between Pre-Test and Post-Test scores.
6. The programme proved to be pedagogically effective in mathematics education.
7. Systematic instructional design contributed positively to conceptual understanding and academic performance.

15. Educational Implications

1. Mathematics teachers should use instructional design principles in lesson planning.
2. Teaching should be activity-oriented and learner-centered rather than purely lecture-based.
3. Proper sequencing of content and reinforcement can improve conceptual clarity.
4. Use of examples, teaching aids, and guided practice can make mathematics more understandable.
5. Schools should encourage teachers to adopt innovative pedagogical approaches in mathematics.
6. Teacher training programmes should include instructional design strategies for mathematics teaching.

16. Recommendations

1. Mathematics should be taught through planned instructional design rather than routine teaching.
2. Secondary school teachers should use student-centered and interactive methods.
3. Mathematics classrooms should include practice sessions, activities, and remedial support.
4. Schools should provide teaching aids and mathematical resources for better learning.
5. Similar instructional programmes should be implemented in other classes and subjects.
6. More experimental studies should be conducted to improve mathematics pedagogy.

17. Conclusion

The present study clearly indicates that instructional design and pedagogical planning play a significant role in enhancing the academic achievement of students in mathematics. The implementation of the one-month mathematics teaching programme resulted in noticeable improvement in the performance of Class IX secondary school students. The structured and

learner-centered approach adopted during the programme helped students understand mathematical concepts more effectively and participate actively in the learning process. The statistical analysis of the collected data through Mean, Standard Deviation, and t-test provided clear evidence that the post-test scores were significantly higher than the pre-test scores. This confirmed the effectiveness of the instructional design-based teaching programme in mathematics education. Therefore, it may be concluded that well-planned instructional strategies, systematic teaching procedures, and sound pedagogical practices contribute positively to mathematics learning. Such approaches should be encouraged in secondary school classrooms to improve students' understanding, achievement, and overall confidence in mathematics.

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