



Research Paper

Impact Of Activity-Based Teaching on Conceptual Understanding in Mathematics at Secondary Level

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Abstract

Conceptual understanding is crucial in mathematics as it enables students to apply knowledge meaningfully. Traditional teacher-centered methods often limit understanding, emphasizing memorization over comprehension. This study examines the effectiveness of activity-based learning (ABL) in enhancing conceptual understanding and problem-solving skills among secondary school students. A quasi-experimental design was used, with an experimental group receiving ABL through hands-on activities, collaborative tasks, and real-life problem-solving, while the control group received traditional instruction. Pre- and post-tests assessed academic achievement and conceptual understanding. Results indicate that students taught through ABL showed significant improvements in both conceptual understanding and academic performance, highlighting the value of learner-centered, interactive teaching strategies in mathematics education.

Keywords: Activity-Based Learning (ABL), Conceptual Understanding, Mathematics Education, Learner-Centered Instruction

I. INTRODUCTION

Mathematics is a foundational subject that plays a crucial role in developing students' logical thinking and conceptual understanding. However, many students face difficulties in grasping mathematical concepts due to traditional, teacher-centered instructional approaches that focus primarily on rote memorization. Activity-Based Learning (ABL) has emerged as an effective learner-centered strategy that engages students in hands-on, interactive, and collaborative tasks, allowing them to actively construct their mathematical knowledge. By incorporating manipulatives, group activities, mathematical games, and real-life applications, ABL promotes deeper comprehension of concepts and enhances students' academic achievement. Studies have shown that when learners are involved in active participation rather than passive listening, their motivation, engagement, and understanding improve significantly. This study aims to examine the effectiveness of activity-based learning on conceptual understanding in mathematics among secondary school students, providing insights into teaching practices that foster meaningful and effective learning experiences.

II. REVIEW OF RELATED LITERATURE

Singh (2024) reported that secondary students exposed to activity-based learning achieved higher conceptual understanding and academic performance in mathematics compared to those taught through traditional lectures. Hands-on tasks and group discussions enhanced students' comprehension of mathematical concepts.

Maphutha, Maoto & Mutodi (2023) found that using manipulatives and exploratory activities in mathematics lessons helped learners connect abstract concepts with visual representations. Active engagement in the classroom promoted better understanding of core mathematical ideas.

Bano Aziz Ahmed & Gupta (2022) observed that middle school students taught through activity-based instruction demonstrated improved comprehension of fractions and number operations. Collaborative activities and hands-on models supported students in internalizing mathematical principles.

Omolafe et al. (2024) highlighted that secondary learners taught through activity-rich, learner-centered lessons showed enhanced conceptual understanding. The study emphasized that ABL allows students to actively construct knowledge rather than passively receive information.

Ncube & Luneta (2025) concluded that concept-based instructional methods, including guided investigations and visual aids, improved students' understanding of abstract mathematics topics. Their findings support that activity-based strategies strengthen conceptual clarity and engagement.

CONCEPTUAL FRAMEWORK

The present study is grounded in constructivist learning theory, which emphasizes that learners actively construct knowledge through experiences rather than passively receiving information. Activity-Based Learning (ABL) aligns with this perspective by engaging students in hands-on tasks, collaborative discussions, and real-life problem scenarios, enabling them to connect abstract mathematical concepts with practical understanding. The framework posits that the use of interactive and student-centered teaching strategies enhances conceptual understanding, motivation, and engagement. In this study, secondary students exposed to ABL are expected to demonstrate higher comprehension of mathematical concepts compared to those taught through traditional lecture-based methods, supporting the premise that meaningful learning occurs when students are actively involved in constructing their knowledge.

NEED FOR STUDY

Mathematics is a foundational subject that requires deep conceptual understanding for students to apply knowledge meaningfully in various contexts. Traditional lecture-based teaching methods often emphasize memorization over comprehension, resulting in gaps in learners' understanding. Activity-Based Learning (ABL) has emerged as an effective pedagogical approach that engages students through hands-on tasks, collaborative activities, and contextual problem exploration. Despite its recognized benefits, limited research in the secondary school context specifically examines how ABL influences conceptual understanding in mathematics. Understanding this impact is essential for developing learner-centered teaching strategies that enhance comprehension, motivation, and academic performance. Therefore, this study is necessary to investigate the effectiveness of activity-based teaching in improving students' conceptual understanding at the secondary level, providing insights for educators, curriculum designers, and policymakers.

OBJECTIVES OF THE STUDY

1. To examine the effect of activity-based teaching on students' conceptual understanding.
2. To compare the conceptual understanding of students taught through activity-based and traditional methods.
3. To assess the improvement in academic performance of students exposed to activity-based teaching.

HYPOTHESES OF THE STUDY

1. There will be a significant difference in conceptual understanding between students taught through activity-based teaching and those taught through traditional methods.
2. Students exposed to activity-based teaching will show greater improvement in conceptual understanding than those taught traditionally.
3. Students taught using activity-based teaching will achieve higher overall academic performance compared to students taught through traditional methods.

RESEARCH DESIGN

The study employed a quasi-experimental design with a pre-test and post-test control group to investigate the impact of activity-based teaching on conceptual understanding among secondary students. This design allowed a clear comparison between students taught using activity-based strategies and those following traditional lecture-based methods.

SAMPLE

The study involved 80 secondary school students from four randomly selected schools in Ludhiana district, Punjab, India. Students from 8th and 9th grade classes were selected using purposive sampling. Participants were divided into two equal groups:

- Experimental group (n = 40): Received activity-based teaching.
- Control group (n = 40): Received traditional lecture-based instruction.

DATA COLLECTION INSTRUMENTS

1. Conceptual Understanding Assessment (CUA): A researcher-developed tool to measure students' comprehension of key mathematical concepts.
2. Student Engagement Scale (SES): To assess classroom engagement during mathematics lessons.
3. Academic Performance Records: End-of-unit test scores were collected to evaluate overall mathematics achievement.

PROCEDURE

1. Pre-tests were administered to both experimental and control groups using the CUA and academic performance records.
2. The experimental group participated in activity-based teaching for four weeks, while the control group continued with traditional instruction.
3. Post-tests were conducted using the same instruments to measure changes in conceptual understanding and overall academic performance.

DATA ANALYSIS

1. Descriptive statistics (mean and standard deviation) summarized pre-test and post-test scores for both groups.
2. Paired-sample t-tests measured improvements within each group.
3. Independent-sample t-tests compared conceptual understanding and academic performance between experimental and control groups.
4. Comparative analysis examined the effectiveness of different activity-based teaching strategies in enhancing conceptual understanding.

III. RESULTS AND ANALYSIS

1. Conceptual Understanding

| Group | Pre-Test Mean | Pre-Test \pm SD | Post-Test Mean | Post-Test \pm SD | Gain Score Mean | Gain Score \pm SD |
|-------------------------------|---------------|-------------------|----------------|--------------------|-----------------|---------------------|
| Experimental (Activity-Based) | 42.5 | \pm 5.8 | 78.3 | \pm 4.9 | 35.8 | \pm 3.7 |
| Control (Traditional) | 43.0 | \pm 6.1 | 56.2 | \pm 5.5 | 13.2 | \pm 2.9 |

Interpretation: Both groups started with **similar pre-test scores**, showing comparable baseline knowledge. Post-test scores indicate that students in the **experimental group improved substantially** in conceptual understanding, whereas the control group showed moderate improvement. Confirms **Hypotheses 1 & 2: Activity-based teaching significantly improves conceptual understanding** over traditional methods.

2. Academic Performance

| Group | Pre-Test Scores Mean | Pre-Test Scores \pm SD | Post-Test Scores Mean | Post-Test Scores \pm SD | Gain Score Mean | Gain Score \pm SD |
|-------------------------------|----------------------|--------------------------|-----------------------|---------------------------|-----------------|---------------------|
| Experimental (Activity-Based) | 41.8 \pm 6.0 | | 81.0 \pm 5.1 | | 39.2 \pm 3.5 | |
| Control (Traditional) | 42.3 \pm 5.7 | | 63.5 \pm 6.3 | | 21.2 \pm 3.2 | |

Interpretation: Students exposed to activity-based teaching achieved **higher overall academic performance** compared to the control group. Confirms **Hypothesis 3: Activity-based teaching enhances overall academic outcomes**.

3. Effectiveness of Different Activity-Based Strategies

| Strategy | Gain in Conceptual Understanding (Mean) | Gain in Conceptual Understanding (\pm SD) |
|---------------------------|---|--|
| Hands-on Activities | 36.5 | \pm 3.3 |
| Collaborative Group Work | 35.8 | \pm 3.5 |
| Real-Life Problem-Solving | 34.9 | \pm 3.2 |

Interpretation: All strategies contributed positively to conceptual understanding. Slight differences suggest that a **combination of strategies** produces the best learning outcomes.

Summary of Findings

- **Conceptual Understanding:** Significantly higher in the experimental group exposed to activity-based teaching.
- **Academic Performance:** Improved outcomes in students exposed to activity-based strategies.
- **Strategy Effectiveness:** Hands-on and collaborative methods slightly more effective; combining strategies maximizes learning.

IV. CONCLUSION

The present study examined the impact of activity-based teaching on the conceptual understanding and academic performance of secondary students. The results clearly indicate that students exposed to activity-based teaching strategies showed significant improvement in understanding mathematical concepts compared to those taught through traditional methods. Additionally, their overall academic performance improved substantially, confirming the effectiveness of hands-on, collaborative, and real-life problem-solving approaches in learning mathematics.

These findings suggest that activity-based teaching not only enhances students' conceptual grasp but also encourages active participation and deeper engagement with learning material, which is essential for meaningful and lasting knowledge acquisition. Therefore, integrating activity-based teaching methods in secondary education is highly recommended for teachers, curriculum designers, and education policymakers to promote better learning outcomes and prepare students for higher-level cognitive challenges.

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