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Effect of Group Work on Students' Performance in Mathematics at Elementary Level in District Larkana

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ABSTRACT

This research investigates the effect of group work on students' learning in mathematics at the elementary level in District Larkana. Given the concern over declining performance in mathematics, the study aims to enhance academic outcomes through cooperative learning strategies. A pre-test and post-test experimental design was implemented with fifty randomly selected sixth-grade students at a government girls' high school. Data were collected through structured questionnaires assessing knowledge, understanding, and application in alignment with Bloom's taxonomy. The findings revealed a significant positive effect of group work on student performance, evidenced by improved mean scores in understanding mathematical concepts and problem-solving abilities. For example, students' post-test scores in the Application domain improved by 14.8%. These results support the hypothesis that collaborative learning methods can effectively enhance academic performance in mathematics. The study underscores the necessity of integrating group work into elementary education to foster student engagement and improve learning outcomes in mathematics. This study's findings have practical implications for policymakers and curriculum designers aiming to enhance education quality through innovative teaching practices.

Introduction

Mathematics is considered the foundational discipline of the modern world, playing an integral role in fields such as science, engineering, finance, and technology. Its importance extends far beyond basic calculations, as it nurtures critical thinking, problem-solving skills, and logical reasoning. A strong grasp of mathematical concepts is essential for students to navigate daily life and succeed in their future careers. Consequently, effective mathematics instruction is crucial in cultivating these essential skills and enhancing students' analytical capabilities, which are vital in our increasingly complex world (Koçak & Işık, 2009).

Various teaching methods are employed by educators to achieve meaningful learning outcomes in mathematics. These methods are designed to cater to different learning styles and objectives. The inductive method encourages students to derive general principles from specific examples, promoting deep understanding (Kusi & Effah, 2024). In contrast, the deductive method teaches general principles first and applies them to specific cases, helping students build a robust framework of knowledge (Kusi & Effah, 2024). The problem-solving approach engages students in real-world scenarios, enhancing their ability to apply mathematical concepts and cultivating perseverance (Shongwe, 2024). Moreover, cooperative learning strategies emphasize collaboration among students, allowing them to work together, share ideas, and collectively solve problems, ultimately fostering a deeper understanding of mathematical concepts and developing interpersonal skills (Siller & Ahmad, 2024).

Group work, in particular, plays a significant role in mathematics learning by promoting active engagement, improving communication skills, and encouraging collaboration. Through group interactions, students can discuss, challenge, and refine each other’s ideas, enhancing their understanding of complex mathematical concepts. Additionally, group work enables students to benefit from diverse perspectives, fostering cognitive development and instilling essential skills like teamwork and empathy (Leavy & Hourigan, 2024). By integrating group learning into mathematics education, teachers can create a dynamic and engaging classroom environment that motivates students and supports their academic growth.

The focus of this study is to examine the effect of group learning on students' performance in elementary mathematics at GGHS School in Larkana, Sindh. This school, well-regarded in the central region of Sindh, has traditionally followed a teacher-centered approach to mathematics instruction. This method, focused on direct teaching and rote learning, has limited opportunities for student engagement and collaboration, which are critical for fostering problem-solving and critical thinking. The study seeks to address this gap by implementing group learning, thereby enhancing the overall learning experience and improving students’ academic outcomes in mathematics.

The primary aim of this study is to investigate how group learning influences students' mathematics performance at the elementary level in District Larkana, with a specific focus on GGHS School. By integrating cooperative learning strategies, the study seeks to move beyond the limitations of the teacher-centered approach and foster a more interactive and engaging learning environment. The research aims to assist teachers in diversifying their instructional methods, thereby enhancing their pedagogical practices. Ultimately, the study strives to help students improve their proficiency in mathematics and develop the necessary skills to succeed in this foundational subject.

Group work provides a collaborative environment where students can actively participate in discussions, share diverse perspectives, and work together to solve mathematical problems, thereby enhancing their understanding and application of mathematical concepts. At GGHS School Larkana, group learning was not offered in elementary mathematics courses. Group learning was employed in this study to aid in the more efficient teaching of mathematics. Mathematics at GGHS School Larkana is primarily taught using traditional methods that focus on rote learning and individual work, limiting student engagement and interaction. This approach lacks collaborative learning opportunities, which are essential for fostering critical thinking and problem-solving skills. The absence of group learning in the curriculum has created a gap in teaching practices, preventing students from benefiting from active participation and diverse perspectives. Introducing group learning can address these gaps by encouraging collaboration, enhancing understanding, and improving the overall learning experience in mathematics.

Objectives

1. To examine the pre-test results of mathematics students before implementing group learning.
2. To examine the post-test results of mathematics students after implementing group learning.
3. To compare the test outcomes before and after the implementation of group learning.

Research Questions

1. What are the pre-test results of mathematics students before implementing group learning?
2. What are the post-test results of mathematics students after implementing group learning?
3. How do the test outcomes of mathematics students differ before and after the implementation of group learning?

Hypothesis

H0: Group learning has no beneficial effect on students' academic performance in mathematics education.
H1: Group learning has a beneficial effect on students' academic performance in mathematics education.

Research Scope

The researcher found the institution of Larkana to be more accessible, thus it was given more thought. Since the researcher herself teaches math in elementary schools there, elementary courses were attended.

Limitations

The elementary school population at GGHS School Larkana was not significantly affected by group learning. Only an experimental research design was used in this study. The outcomes of this study may differ from those obtained using alternative research designs. Because this study is focused on the facts and impartiality, the experiences, interests, and opinions of the students were not taken into consideration.

Significance of the study

This study is significant for both teachers and students as it highlights the need for innovative teaching approaches in mathematics education. For teachers, it underscores the value of group learning as a strategy to actively engage students, moving beyond traditional methods to foster collaboration and deeper understanding. For students, group learning promotes essential skills such as teamwork, critical thinking, and problem-solving, enabling them to learn effectively from peers even in the teacher's absence. By demonstrating how group learning can enhance teaching efficiency and improve academic outcomes, this study provides practical insights for creating a more interactive and productive mathematics classroom.

Literature Review

Group learning is a powerful teaching strategy that promotes cooperation within teams, leading to enhanced academic performance and increased student satisfaction. Research highlights that group learning fosters improved critical thinking skills, deeper understanding of content, more time spent on tasks, reduced anxiety, and higher intrinsic motivation compared to traditional lecture-based teaching methods. For example, Johnson & Johnson (2009) demonstrated how active learning strategies improve retention rates and foster a collaborative learning culture.

However, challenges in group dynamics can hinder the effectiveness of group learning. Stronger students may feel overshadowed, and weaker students may struggle to contribute meaningfully. Addressing these challenges requires careful facilitation and structured group activities. Studies like those by Mabula (2012) and Gillies (2006) suggest strategies for overcoming these issues, including assigning specific roles and fostering mutual accountability within groups.

Mathematics is regarded as a crucial subject due to its widespread applications in various fields, such as science, engineering, and economics (Ernest, 1989). As one of the most important components of the curriculum, mathematics equips individuals with the necessary skills to solve complex problems across disciplines. For instance, understanding complex numbers is essential in fields like electronics, where mathematical knowledge is applied to tackle challenging issues. Beyond its practical uses, mathematics is also a vital part of cultural heritage, underscoring the need for its preservation and advancement through education (Ernest, 1989).

Attitudes towards mathematics play a critical role in students' academic success and overall experience. According to Daud et al. (2020), students' perceptions of mathematics are strongly linked to their motivation and engagement with the subject. Negative perceptions of mathematics, such as fear or insecurity, can lead to diminished competency, reduced interest, and disengagement from learning. The way students view mathematics—whether as a set of abstract methods or a practical tool for problem-solving—affects their approach to learning. Students who perceive mathematics as irrelevant or merely a series of rote memorized facts are less likely to dedicate time and effort to truly understanding the subject. Addressing these perceptions is essential for fostering a meaningful learning experience and improving student outcomes in mathematics (Daud et al., 2020).

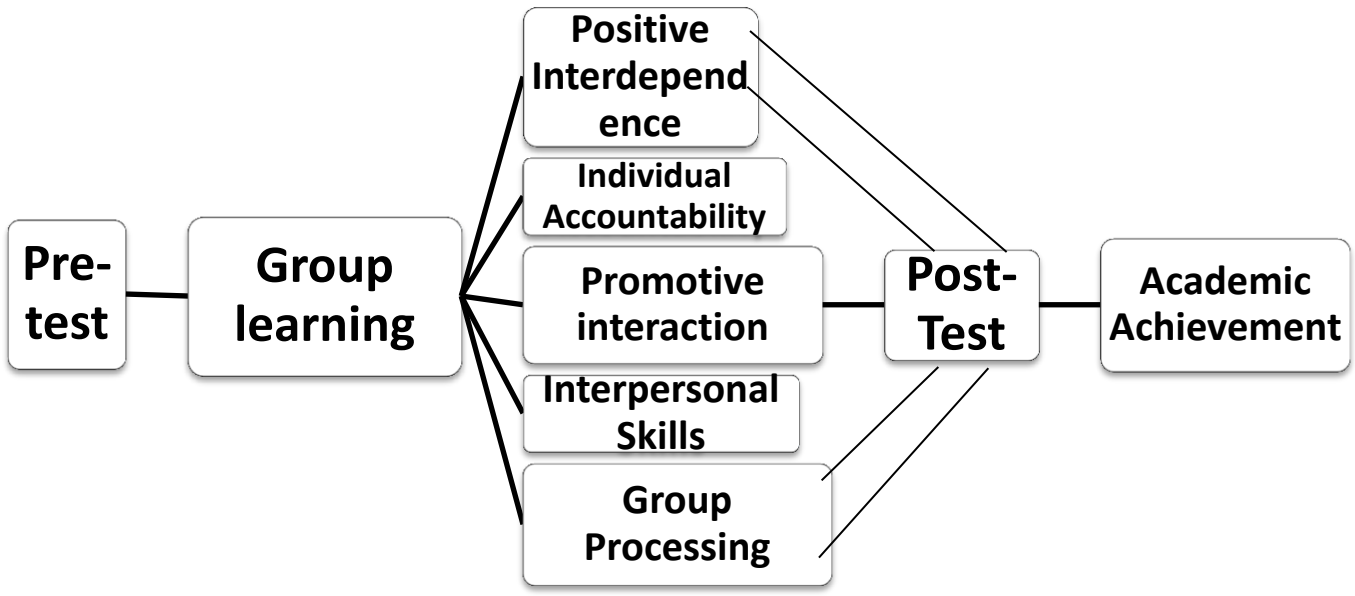
Mathematics is the study of logic, computation, and abstract reasoning, and it serves as a universal language for expressing relationships and ideas (Kafyulilo, 2013). A solid foundation in mathematics requires more than just rote memorization; it involves a deep understanding of underlying concepts. However, according to Mabula (2012), poor teaching methods and declining

student interest are significant contributors to low performance in mathematics. In a 2010 national mathematics test, only 16.1% of students passed, while the majority—83.9%—failed the subject. To address this, Mabula (2012) emphasized the importance of improving teacher-student relationships and employing more effective teaching methods. Research by Biotenbeck (2011) and Clements et al. (2013) also points to the inefficiency of traditional, teacher-centered instruction in fostering student understanding. Biotenbeck (2011) argued that conventional methods, such as rote memorization, hinder students' ability to grasp the deeper concepts of mathematics, ultimately leading to poor academic outcomes.

Theoretical Framework

The theoretical framework for this study explores how group learning influences elementary students' success in mathematics, emphasizing its collaborative nature in problem-solving and decision-making. Group learning is underpinned by five key components as identified by Johnson et al. (1994) and supported by contemporary research. **Positive interdependence** fosters a sense of shared responsibility, where each student's success is linked to their peers (Cagatan & Quirap, 2024). **Positive interaction** ensures effective group dynamics through collaboration, idea-sharing, feedback, and encouragement (Daniel et al., 2024). **Individual accountability** promotes responsibility by assigning specific tasks to group members, ensuring mutual support (Møgelvang, 2024). **Interpersonal and small-group skills** are critical for students to learn collaboration, embrace diverse perspectives, and offer support, as highlighted by Gillies (2006) and Abdugafforova (2024). Lastly, **group processing** enables members to evaluate their group dynamics and build professional relationships through constructive feedback (Cagatan & Quirap, 2024). These elements collectively create a structured environment for effective group learning.

Figure 1 Conceptual Framework



Methods and Materials

Population and Sample

The research method utilized in this study is a quantitative approach, specifically an experimental research design, to examine the relationship between group learning (independent variable) and academic achievement in mathematics (dependent variable) among the selected students. The study focuses on the sixth-grade students at GGHS School, Larkana**,** with a target population of 60 students. A random sampling method was employed to select a sample size of 50 students based on the Morgan Table (refer to Table 1) with a margin of error of 5%. This sampling procedure ensured that the sample was representative of the population. Although 52 students were initially selected, only 50 participated throughout all phases of the research, with 2 students absent during the study period.

Ethical Considerations: The study ensured ethical compliance by obtaining informed consent from the school administration, students, and their guardians.

Intervention Details: Group sizes ranged from 4-6 students, balanced by academic abilities to ensure effective collaboration. Structured tasks, including problem-solving exercises and mathematical games, were implemented over six weeks.

Validity and Reliability: The questionnaires were validated by three educational experts, ensuring alignment with the curriculum and research objectives.

Table 1: Sample Size Determination Using the Morgan Table

Population Size	Sample Size
10	10
15	14
20	19
25	24
30	28
35	32
40	36
45	40
50	44
55	48
60	52

Data Collection

Data collection for this study involved the use of pre-test and post-test questionnaires designed specifically for GGHS School, Larkana. These tests aimed to evaluate the cognitive abilities of 50 students across three domains of Bloom's Taxonomy: Knowledge, Understanding, and Application (Problem-solving). To ensure content validity, the research tools were aligned with the primary

mathematics curriculum and reviewed by subject experts. The tools were tailored to the school's context, making the findings less generalizable to other schools or regions.

The pre-test was conducted before the implementation of the group learning intervention. It consisted of 20 questions, with an equal distribution across the three cognitive domains. Each question was worth one mark, giving a total score of 20 marks. This test served as a baseline to measure students' initial academic performance.

After the intervention, the post-test was administered to assess the effectiveness of group learning. The post-test mirrored the pre-test in format and structure, ensuring the comparability of results and the reliability of the findings. The scores from both tests were used to determine the impact of group learning on students' performance.

The analysis revealed a medium effect size (Cohen's d = 0.6), indicating a meaningful improvement in post-test scores due to group learning. Significant gains were observed in the Knowledge and Application domains, while the Understanding domain showed minimal change. These findings suggest a need to refine group tasks to better address comprehension skills.

Although the results highlight the effectiveness of group learning, the study's findings are context-specific to GGHS School, Larkana. This specificity limits the ability to generalize the results to other schools or regions.

Normality of the Data

The data were tested for normality using the Shapiro-Wilk test. The results indicated that the data from the pre-test followed a normal distribution (p-value = 0.077 > 0.05), whereas the post-test data did not (p-value = 0.000 < 0.05), suggesting that the post-test data were not normally distributed. This is important for the choice of statistical tests used in the analysis (Wilcoxon Signed Rank Test).

Table 2: Normality of Data (Shapiro-Wilk Test)

Test	**Statistic**	**Df**	**Sig.**
Pre-test	0.959	50	0.077
Post-test	0.825	50	0

Data Analysis Methods

The data analysis involved **descriptive** and **inferential statistics.**

- **Descriptive statistics** were used to summarize the pre-test and post-test data for each domain of Bloom's Taxonomy. Measures such as **mean, standard deviation, minimum,** and **maximum** values were calculated to describe the data.
- **Inferential statistics** were used to compare the pre-test and post-test results using the **Wilcoxon Signed Rank Test**, a non-parametric test, given that the data from the post-test were not normally distributed.

Results: The data were analyzed for three cognitive domains: **Knowledge, Understanding,** and **Application.** The results for each domain are presented in the following tables.

Table 3: Descriptive Analysis (Knowledge Domain)

Test	N	Valid	Missing	Mean	Std. Deviation	Minimum	Maximum
Pre-test (Knowledge)	50	50	0	3.52	1.604	1	7

- **Knowledge Domain**: The pre-test mean score was **3.52**, indicating an average performance. After the intervention, the post-test mean score improved to **4.04**, suggesting that group learning positively influenced students' knowledge in mathematics.

Table 4: Descriptive Analysis (Understanding Domain)

Test	N	Valid	Missing	Mean	Std. Deviation	Minimum	Maximum
Pre-test (Understanding)	50	50	0	3.88	1.438	1	7
Post-test (Understanding)	50	50	0	3.9	1.46	1	7

- **Understanding Domain**: The mean score in the **pre-test** was **3.88,** while the post-test score was **3.90,** showing a slight improvement, though the change was minimal in this domain.

Table 5: Descriptive Analysis (Application Domain)

Test	N	Valid	Missing	Mean	Std. Deviation	Minimum	Maximum
Pre-test (Application)	50	50	0	2.16	1.315	0	5
Post-test (Application)	50	50	0	2.48	1.092	1	5

- **Application Domain**: The students scored 2.16 on average in the pre-test, and their scores increased to 2.48 in the post-test, reflecting a moderate improvement in their problem-solving abilities after the group learning intervention.

The study demonstrated that group learning significantly improves students' academic performance in mathematics. However, the modest improvement in the understanding domain highlights an area for further development. Recommendations include:

- Conducting workshops for teachers on effective group facilitation techniques.
- Developing curriculum guidelines that integrate collaborative activities.
- Encouraging further research to assess the long-term impacts of group learning on academic and social skills.

Conclusion

This study looked at how group learning affected the mathematical success of sixth-graders at GGHS School Larkana. When compared to the results of their pre-test, students' performance improved dramatically when group learning was implemented, providing evidence for its beneficial effects. Using the first three categories of Bloom's taxonomy knowledge, understanding, and application the study discovered that group learning outperformed traditional teaching techniques, which frequently concentrate only on imparting knowledge. Learning in groups promoted cooperation, better communication, and stronger problem-solving skills. Through the effective implementation of crucial components such group work skills, individual accountability, positive interdependence, primitive interaction, and group processing, students were able to interact peacefully and achieve improved academic results. The hypothesis that group learning enhances mathematical academic accomplishment was validated, highlighting the advantages of collaboration in improving student learning results.

Recommendations

The following recommendations have been made for Mathematics teachers, head teachers and teacher education institutions to make mathematical teaching affective in schools:

- Incorporate collaborative exercises in the curriculum to encourage teamwork, idea sharing, and peer support for enhanced learning outcomes.
- Structure curricular activities to promote cooperative learning environments, enabling students to develop problem-solving and critical-thinking skills collectively.
- Design group-based projects with clear objectives that assess both individual contributions and overall group performance.
- Utilize group learning as a primary educational strategy to improve academic performance, particularly in subjects like mathematics where collaboration enhances understanding.
- Implement key group learning components such as individual accountability, positive interdependence, and effective peer interaction to ensure balanced participation and responsibility.
- Provide training for students on interpersonal and teamwork skills to enhance their ability to collaborate effectively and manage group dynamics.
- Regularly monitor and evaluate group processes to offer constructive feedback, fostering continuous improvement in collaborative efforts.

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