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Enhancing Mathematical Problem-Solving In Diverse Learners Using Constructivist Approaches

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Abstract
This study investigates how well constructivist teaching methods can improve different learners' ability to solve mathematical problems. Students have a diverse range of learning needs, cognitive capacities, cultural backgrounds, and prior knowledge in an increasingly diverse classroom setting. These disparities are frequently not adequately addressed by traditional teaching approaches, which results in gaps in performance and comprehension.Constructivist pedagogy offers a framework for getting students interested in meaningful mathematical exploration by emphasizing active learning, teamwork, and real-world issue situations.The study looks into how constructivist methods might be modified to help students with different profiles and enhance their capacity to explore, evaluate, and resolve mathematical issues. The study uses a mixed-methods strategy to look at both qualitative shifts in learner confidence and engagement and quantitative improvements in problem-solving performance.The results show that constructivist methods foster equity, involvement, and critical thinking among different learners in addition to improving mathematical comprehension. This study adds to the expanding corpus of research supporting inclusive and student-centered math education.
Keywords: *Mathematical Problem-Solving, Constructivist Approaches, Diverse Learners, Inclusive Education, Student-Centered Learning*

1.0 INTRODUCTION

The fundamental study of mathematics fosters the logical reasoning, critical thinking, and problem-solving abilities necessary for success in today's world (Kilpatrick, Swafford, & Findell, 2001). Effective math instruction is still difficult to achieve, though, especially when dealing with the many requirements of students in inclusive classrooms today (Tomlinson, 2014). Students' cognitive capacities, learning preferences, socioeconomic backgrounds, language skills, and past knowledge all differ greatly, and these factors affect how they comprehend and resolve mathematical issues (National Council of Teachers of Mathematics [NCTM], 2014; Boaler, 2016).Conventional, teacher-centered approaches prioritize memorization over in-depth conceptual knowledge and can fall short in engaging all students (Hiebert et al., 1997). On the other hand, constructivist teaching methods, which see education as a dynamic, student-centered process, present a viable substitute (Fosnot & Perry, 2005).Learners are encouraged to develop their own ideas, form meaningful connections, and become autonomous problem solvers through constructivist techniques like inquiry-based learning, real-life contextual challenges, peer collaboration, and reflective thinking (Vygotsky, 1978; Bransford, Brown, & Cocking, 2000). Although constructivist pedagogy is becoming more and more popular, little is known about how well it works to help varied learners such as those with special educational needs, diverse cultural backgrounds, or different academic levels solve mathematics problems (Chiu, 2007; Florian & Black-Hawkins, 2011). Investigating how constructivist methods may be modified and applied to take into account this diversity and advance equity in mathematics instruction is vital.Thus, the purpose of this study is to investigate how constructivist teaching strategies can improve different learners' ability to solve mathematical problems. By doing this, it hopes to support the growth of inclusive, successful, and learner-centered mathematics education.

1.1 Definitions:

1.1.1 Constructivist Pedagogy: A teaching approach predicated on the notion that students generate knowledge via experiences and interactions. Active learning, in which students engage with the content and reflect on what they have learned, is highly valued (Fosnot & Perry, 2005; Piaget, 1952; Vygotsky, 1978). .

1.1.2 Diverse Learners: The term "diverse learners" refers to students from a variety of backgrounds, including those that differ in financial status, language, culture, aptitude, and preferred methods of learning (Tomlinson, 2014; Gay, 2010). This term includes students with special educational needs, English language learners, and students from underrepresented groups. Social identities in education encompass a range of factors such as age, race, socioeconomic status, gender identity, sexual orientation, and country of origin. Examples of diversity include ability variety, age diversity, gender diversity, ethnic diversity, religious diversity, socioeconomic diversity, experience diversity, and sexual orientation diversity. These identities are intersectional and overlap over time, affecting students' cognitive, physical, learning capacities, age, gender, ethnicity, religion, socioeconomic status, life experiences, and sexual orientation.

1.1.3 Collaboration: An approach in which students work together to complete tasks or resolve problems. Collaborative learning, which emphasizes teamwork and communication, allows students to learn from one another (Dillenbourg, 1999; Johnson & Johnson, 2009).

1.1.4 Inclusive Education: UNICEF (2017) advocates for inclusive education, ensuring all students have access to resources and facilities, regardless of their abilities or needs, thereby promoting a more inclusive and effective learning environment. The Ministry of Education and NCERT are promoting inclusive, high-quality education for students with special needs through initiatives like ePathshala and mobile app, providing free access to NCERT books and e-content (UNICEF, 2017; NCERT, 2021) .Disability impacts learning potential, necessitating an adaptable educational system that meets individual needs, fostering community, and improving learning outcomes for all students.

1.1.5 Mathematical Understanding: The ability to comprehend mathematical concepts, relationships, and operations. This includes procedural knowledge as well as the ability to apply mathematics in a range of contexts . It involves both procedural fluency and conceptual understanding (Kilpatrick, Swafford, & Findell, 2001; NCTM, 2014).

1.1.6 Learning Outcomes: Information, skills, attitudes, and values that students should acquire as a result of education. The study's learning objectives specifically include improvements in students' mathematical understanding and problem-solving skills (Biggs & Tang, 2011).

1.1.7 Engagement: The level of drive, zeal, and participation displayed by learners throughout the learning process. High engagement is often associated with better academic performance and positive attitudes about learning (Fredricks, Blumenfeld, & Paris, 2004).

1.1.8 Problem-Solving Method: A teaching strategy that encourages students to solve mathematical problems by applying logic and research. By asking students to think through, organize, and evaluate solutions to real-world problems, this method promotes critical thinking (Polya, 1957; Schoenfeld, 1992).

1.1.9 Diverse Learner: The term "**diverse learners**" refers to students from a variety of backgrounds, including those that differ in financial status, language, culture, aptitude, and preferred methods of learning. This term includes students with special educational needs, English language learners, and students from underrepresented groups (Tomlinson, 2014; Florian & Black-Hawkins, 2011).

1.2 Background Of The Study:

Mathematics instruction has evolved to cater to diverse student needs, reducing reliance on standardized processes and rote memorization. This is particularly challenging for students in each grades, who transition to abstract thought.Constructivist teaching fosters cooperation and differentiation, promoting a welcoming environment for diverse learners. Research shows problem-solving enhances students' attitude towards mathematics, boosting drive and perseverance. Constructivist pedagogy, rooted in Piaget and Vygotsky, emphasizes contextual learning and problem-solving to help students build knowledge through social interaction and active involvement, fostering deeper comprehension and critical thinking abilities.This paper explores the effectiveness of a constructivist educational approach in enhancing learning outcomes for diverse learner of each grade, focusing on problem-solving techniques and their impact on student engagement, comprehension, and mathematical performance in a diverse educational environment.Constructivist approaches to mathematics education, including inquiry-based learning, the use of manipulative, scaffolded instruction, and collaborative problem-solving, have demonstrated promise in assisting students from a variety of backgrounds in acquiring critical problem-solving abilities. These strategies offer a variety of ways for learners with varying learning styles, language skills, and cultural backgrounds to gain an understanding of complicated mathematical concepts.

1.3 Problem Statement:

Many students still fail to develop effective problem-solving skills despite efforts to improve mathematics education, particularly those from varied backgrounds where there are variances in language, culture, learning styles, and cognitive ability. These individual distinctions are frequently ignored by traditional, lecture-based teaching approaches, which results in disengagement and poorer mathematical proficiency. Despite efforts to improve mathematics instruction, students in each grades struggle with concepts and abilities, leading to poor academic performance and dissatisfaction due to inadequate engagement and cultural differences. The constructivist pedagogical method, focusing on social knowledge creation and active learning, offers a viable substitute, but its implementation in diverse classrooms remains uneven. This study focuses on the following problems:

a) Motivation and Involvement
b) Knowledge and Proficiency
c) Strategies and Preparedness of Teachers

1.3.1 Motivation and Engagement: How many a constructivist approach that emphasizes problem-solving strategies improve the motivation and engagement of diverse students in mathematics?

1.3.2 Understanding and mastering: What is the impact of this approach on the conceptual understanding and mastering of mathematical concepts across students with different backgrounds and ability levels?

1.3.3 Strategies and Preparation for Teachers: What challenges do educators have when implementing constructivist methods in a diverse classroom, and what resources or support are needed? The study aims to clarify how well constructivist teaching methods promote equitable mathematics learning results for all students by looking at these issues.

1.4 Identify the Research gaps:

1.4.1 Limited Research on diverse learners in constructivist settings: Although constructivist methods like inquiry-based learning and problem-based learning are frequently advocated, little attention has been paid to how they affect diverse learners in particular, such as those from a range of socioeconomic and cultural backgrounds, students with learning disabilities, or students who face language barriers.

1.4.2 Limited proof of long-term effects: The majority of current research concentrates on immediate improvements in problem-solving skills. Longitudinal research evaluating whether constructivist methods result in long-term gains in diverse learners' capacity to solve mathematical problems are lacking.

1.4.3 One-size-fits-all application of constructivism: Constructivist tactics are frequently applied consistently without being modified to account for the variability of learners. To accommodate varied learner demands, such as those of visual and auditory learners, it is necessary to investigate how constructivist approaches might be differentiated.

1.4.4 Insufficient integration of theory and classroom practice: A large number of research are still theoretical in nature and do not have a robust classroom implementation. Examining useful teaching techniques and preparing teachers to apply constructivism to a variety of student groups is where there is a gap.

1.4.5 The underappreciated contribution of digital tools to constructivist mathematics education: Although digital platforms and instructional technology have grown in significance, little is known about how they can help diverse learners solve constructivist math problems.

1.4.6 Insufficient student voice and feedback: Test results and instructor evaluations are the main sources of data for many studies. There is a lack of knowledge regarding how constructivist approaches impact students' confidence, engagement, and development of mathematical strategies based on their input and viewpoints.

1.4.7 The research gap statement is summarized as follows: Although constructivist teaching methods are widely acknowledged to improve mathematics comprehension, there is still a substantial research gap on their unique effects on a variety of learners. Comprehensive understandings of how constructivist methods can be modified to accommodate different learning styles, incorporated into classroom instruction, and aided by technology to develop long-term mathematical problem-solving abilities are lacking in the current research.

1.5 Purpose of the Study:

Investigating how well constructivist teaching methods can improve different learners' ability to solve mathematical problems is the aim of this study. It seeks to investigate how constructivist methods like inquiry-based learning, group projects, and real-world issue scenarios can be modified to accommodate students with different learning preferences, skill levels, and backgrounds. In order to inform inclusive and equitable mathematics instruction, the project aims to provide empirical evidence on the effects of different techniques on students' problem-solving skills, engagement, and conceptual comprehension.

1.6 Objectives:

The proposed study objectives to achieve the following goals:

1. To evaluate how well constructivist methods enhance mathematical problem-solving abilities.
2. To identify particular constructivist strategies that caters to the various learning requirements of students.
3. To investigate how students view and participate in constructivist-based problem-solving activities.
4. To investigate the potential and difficulties instructors have when implementing constructivist teaching strategies in classrooms with diverse classrooms.

1.7 Research Questions:

Research topics can be of the following types:

a) Motivation and Engagement
b) Learning Outcomes
c) Differentiation
d) Teacher Perspectives
e) Cooperation and Social Interaction

1.7.1 Engagement and Motivation: How do varied learners in grades 6–8 respond to a constructivist pedagogical approach centered on problem-solving techniques in terms of their motivation and engagement in mathematics?

1.7.2 Learning Outcomes: How much can using a constructivist framework to a problem-solving approach improve diverse learners' arithmetic performance and comprehension?

1.7.3 Differentiation: In a varied classroom, how might the constructivist method is modified to accommodate students with various learning preferences and skill levels?

1.7.4 Teacher Perspectives: How do educators feel about using constructivist problem-solving techniques in their teaching of mathematics to a diverse student body?

1.7.5 Collaboration and Social Interaction: How do students from diverse backgrounds' social dynamics and learning outcomes change when they work together to solve problems in a constructivist classroom?

1.8 Significance of the Study

This research is important for a number of reasons:

a) Improving Learning Outcomes
b) Dealing with Educational Diversity
c) Useful Consequences for Teachers
d) Improving Attitude and Student Engagement
e) Supporting Research in Education
f) Informing Curriculum Development

1.8.1 Improving Learning Outcomes: By investigating the impacts of a constructivist pedagogical approach based on problem-solving strategies, this study aims to improve the mathematical knowledge and skills of various students in grades 6–8. Improved learning results can foster greater confidence and interest in mathematics, laying a strong foundation for future academic success.

1.8.2 Dealing with Educational Diversity: As classrooms become more varied, it is imperative to adopt teaching strategies that cater to the various requirements of the students. This study contributes to the discussion on inclusive education by providing insights into how constructivist approaches can effectively engage and support students with a range of backgrounds, abilities, and learning styles.

1.8.3 Useful Consequences for Teachers: The results could be a helpful guide for educators who want to implement constructivist teaching methods in their classrooms. By highlighting effective strategies and potential roadblocks, this study can assist in directing professional development and teacher training programs, providing educators with the tools they need to create an engaging and supportive learning environment.

1.8.4 Improving Attitude and Student Engagement: By highlighting the potential of constructivist strategies to improve student engagement and attitudes toward mathematics, the project aims to create a more pleasant learning environment. Motivated and involved students are more likely to pursue postsecondary study in mathematics and related fields, which contributes to a more mathematically literate society.

1.8.5 Supporting Research in Education: This study will add to the body of knowledge on constructivist pedagogy and problem-solving strategies in mathematics education. Because it focuses specifically on diverse learners in the critical transitional grades of 6 to 8, it will fill a vacuum in the literature and encourage further study in this area.

1.8.6 Informing Curriculum Development: The results of the study may influence curriculum design by promoting the use of problem-solving strategies in the mathematics curriculum. These modifications can promote a greater understanding and application of mathematical concepts, which aligns with modern educational standards that prioritize practical application and critical thinking.

1.9 Literature Review

1.9.1 Theoretical Framework:

This study is based on several interrelated concepts that provide a comprehensive understanding of the constructivist educational method, which is focused on problem-solving strategies for a range of arithmetic learners.

1.9.1.1 Constructivist Learning Theory: Knowledge is produced through social contact and active engagement, according to constructivist learning theory, which is mostly associated with Jean Piaget and Lev Vygotsky. Piaget contends (1952) that students progress through phases of cognitive development and that learning occurs when they actively engage in the process, allowing them to build on prior knowledge. Vygotsky (1978) emphasized the social aspects of learning by putting out the concept of the Zone of Proximal Development (ZPD), which emphasizes the importance of group learning and guidance from more seasoned peers or teachers.

1.9.1.2 Problem-Based Learning (PBL): An instructional approach that assigns students real-world problems to solve. This method encourages collaboration, critical thinking, and the application of information in practical contexts (Hmelo-Silver, 2004). PBL aligns with constructivist principles by promoting active learning and assisting in the generation of knowledge through inquiry and exploration. PBL in mathematics can boost students' enthusiasm and engagement by connecting abstract concepts to real-world situations(Savery, 2006 .

1.9.1.3 Differentiated Instruction: Advocated by educators like Carol Ann Tomlinson, differentiated instruction aims to adapt teaching strategies to meet the needs of different student populations. This framework acknowledges the varied origins, abilities, and learning styles of its learners by emphasizing flexible grouping, a range of teaching modes, and responsive assessment strategies (Tomlinson, 2014).

1.9.1.4 Cognitive Load Theory: John Sweller's theory states that when working memory limitations are considered in instructional design, learning occurs most efficiently. Problem-solving strategies that scaffold learning can help students focus on important concepts and enhance comprehension by lowering needless cognitive load and providing appropriate challenges (Sweller, 1988; Sweller, Ayres, & Kalyuga, 2011).

1.9.1.5 Social Constructivism: Social constructivism expands on constructivist learning theory by emphasizing the role that social interactions play in the learning process. It claims that in order for students to co-create knowledge, they must cooperate and interact with one another. In a diverse classroom, this perspective encourages group projects and peer-to-peer learning, which can enhance students' understanding of mathematics and foster a sense of community (Palincsar, 1998).

1.9.2 Studies Related to Problem based learning

Tailor, V. (2019) investigated micro polar fluid issues beyond various geometries. Popular numerical techniques for examining blood flow and heat transfer in arterial systems include the Finite Difference Method, Runge-Kutta Fourth Order Method, Finite Volume Method, Finite Element Method, Boundary Element Method, and Spectral Element Method. A model will be constructed, mathematical formulations will be carried out, equations will be non-dimensional zed, numerical methods will be developed, solutions will be obtained, parameter impacts on flow quantities will be assessed, and other factors will be examined. Coupled non-linear differential equations in micro polar fluids provide difficulties. As magnetic, material, suction, and angular parameters increase, micro polar fluid and fluid velocity decreases. While angular velocity falls with melting and micro polar parameters, it rises with buoyancy and radiation factors.

Tong, D. H., Uyen, B. P., & Le Thi Quynh Nhu, L. K. (2021) conducted the study to ascertain how problem-based learning (PBL) affected the subject of mathematical relationships within a triangle and the triangle's solution. A pretest-posttest control group design was used for this study. The study's sample consisted of 81 10th graders. In order to investigate perspectives on PBL, student opinions were also collected. Based on the results, students in the PBL group performed better than those in the control group.The results indicated that students in the PBL group were better at applying their mathematical skills and knowledge to real-world problems. **Kolothumthodi, R. (2022)** investigated how secondary school learners' ability to solve geometry problems was affected by a virtual learning environment that used Geogebra. Using an experimental approach, the study focuses on 90 students from two divisions of IX standard boys and girls at Al-Anvar High School in Kuniyil, Kerala. The study employs a nonequivalent group design and a quasi-experimental pre-test post-test. Among the cognitive abilities required for problem-solving are generalization, experimentation, inference, and verification. After consulting with specialists and reviewing existing material, the researcher created a Geometry Problem Solving Ability Test. After analyzing 35 problems, the study discovered that a subsample of students' problem-solving skills in geometry were improved more effectively by the Virtual Learning Environment utilizing Geogebra than by other approaches.

Ural and Dadli (2020) looked into how seventh-grade students' environmental knowledge, attitudes, and reflective thinking abilities were affected by problem-based learning (PBL).53 students in the seventh grade from two groups. The study's sample consisted of 26 PBL students and 27 control group students of two distinct Turkish government school classes. A quasi-experimental pre-test post-test control group design was used for the investigation. Data analysis revealed that the PBL group outperformed the others in terms of attitude and environmental knowledge. Students in the PBL and control groups did not significantly differ in their capacity for reflective thought.

1.9.3 Studies Related to Constructivist Pedagogical approach

Shahida, N. (2023) study on secondary school teachers' perceptions of the constructivist approach in teaching revealed that female teachers had a favorable attitude (21.12%), while male teachers were unfavorable (27.85%). The Teachers' Attitude Scale towards Constructivist Approach in Teaching (TASCAT) was administered to 895 teachers in Meghalaya's 7 districts, and no significant difference was found in attitude between male and female teachers.

Lyngdoh, S. W. (2016) examined teachers' attitudes towards a constructivist teaching approach in Meghalaya. It found that female teachers had a highly favorable attitude (21.12%), while male teachers (27.85%) were highly unfavorable. However, there was no significant difference between male and female teachers in the same programs.

Singh, G. (2017) study compared the impact of self-learning modules and a constructivist approach on secondary school students' academic performance and thinking skills. The study involved 70 Kurukshetra 9th class students, divided into two groups: Group A taught Social Science through self-learning modules and Group B taught Social Science through a constructivist approach. The results showed no significant difference in mean gain scores between the two approaches after the experiment. The study highlights the need for further research on the effects of self-learning and constructivist approaches on academic performance and thinking skills.

2.0. Methodology

2.0.1 Research Design: The study will employ a pre-test/post-test control group structure and a quasi-experimental methodology. This design makes it possible to compare two groups: the experimental group, which was taught constructivist strategies, and the control group, which was taught traditional methods. To gain a deeper understanding of learner experiences, it could also incorporate qualitative elements (such as student interviews and classroom observations).

2.0.2 Participants

Sample Size: 30 students
Grade Level: Middle school (e.g., Grade 6–8)
Diversity Factors: Cultural, linguistic, academic performance levels, learning styles
Selection Method: random sampling
Location: urban school in Gurugram district with multilingual learners)

2.0.3 Instrument Tools:

1. Mathematical problem-solving based question paper of Pre-test and Post-test.
2. Question paper consists of real life situation, problem-solving tasks, creativity, puzzles, reasoning, thinking, Motivation and Engagement, Learning Outcomes, Differentiation, Teacher Perspectives, Cooperation and Social Interaction questions.
3. Student Questionnaire:

Objective: To gather qualitative data on student engagement, motivation, and perceptions of the constructivist approach.

a) **Structure**:

- **Demographic Information**: Age, gender, grade level, and any relevant background information (e.g., previous math experiences).
- **Likert Scale Questions** (e.g., 1-5 scale):

1) "I feel confident in my ability to solve math problems."
2) "I enjoy working collaboratively with my classmates on math tasks."
3) "I believe that learning math through problem-solving helps me understand the concepts better."

- **Open-Ended Questions**:

1) "Describe a problem-solving activity that learner found particularly helpful. Why was it helpful?"
2) "What challenges did learner face during the problem-solving activities?"

3) "How do learners feel learner understanding of math has changed since participating in this study?"

2.0.4 Instructional Strategies (Constructivist-Based)

- Problem-Based Learning (PBL): Real-world problems with no single correct answer
- **Collaborative Group Work:** Peer discussion and shared solutions
- **Use of Manipulative and Visual Aids:** Especially helpful for abstract concepts
- **Socratic Questioning:** Guided discovery through probing questions
- **Scaffolding:** Supportive prompts that gradually fade as learners become more independent
- **Reflective Activities:** Encourage met cognition and self-assessment

2.1 Data Collection

2.1.1 Quantitative Information:

Pre-Test and Post-Test: Standardized mathematics achievement tests given prior to and following the intervention to gauge learning objectives.

2.1.2 Qualitative Information:

Classroom Observations: Consistent observations made in accordance with a standardized observation strategy to record student interactions and teaching strategies. Samples will be taken by the investigator keeping these aspects in mind:

a) Identify teacher's mathematics teaching strategies.
b) Assess student's mathematics interest, aptitude, and achievement.
- If children are interested in mathematics, then why?
- If children are not interested in mathematics, then why not?

c) Observe students and teachers before teaching through feedback.
d) Observe students and teachers after teaching through feedback.
e) Identify the student's previous learning outcomes before teaching.
f) Identify students learning outcomes after teaching.
g) Provide a constructivist pedagogical approach based on the problem-solving method.

Therefore, the investigator shall use a quasi-experimental research design to conduct the proposed study. Also, a variety of tools and techniques, including pre-tests and post-tests, observations, and questionnaires, can be integrated for further research purposes.

2.1.3 Data Collection Methods:

Table 1: Research Design Framework

Research Approach	Mixed Method (Quantitative and Qualitative)
Research Design	Quasi-Experimental Method
Population	Middle School Students (Grades 6^{th} to 8^{th})
Sample Size	30 students, split evenly between the experimental and control groups.
Sampling Method	Stratified Random Sampling
Tools	Pre-tests and post-tests, questionnaires, and classroom observation

2.2 Data Analysis:

2.2.1Quantitative Findings

The study involved 30 students: 15 in the control group (traditional teaching) and 15 in the experimental group (constructivist approach). Pre-test scores in both groups were similar, indicating a comparable baseline.

N = 30

SD ≈ 10

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2.2.2 Effect Size (Cohen's d)

Cohen's d = $(M_2 - M_1) / SD_{pooled}$

Where

- $M_1 = 5.7$ (Control Improvement)
- $M_2 = 16.4$ (Experimental Improvement)
- Standard Deviation = 10
- N = 30

D = (16.4-5.7)/10 = 1.07

Effect Size (Cohen's d) = 1.07 (large effect)

$SD_1 = SD_2 = 10$

$n_1 = n_2 = 30$

t-value: $t = (10.7)/\sqrt{6.67 + 6.67} = 10.7/\sqrt{13.33} \approx 10.7/3.65 \approx 2.93$

p-value

An independent-sample t-test showed that the difference in post-test scores between the experimental and control group was statistically significant ($p < 0.05$), suggesting the constructivist approach had a meaningful impact on problem-solving skills.

2.2.3 Findings:

1. **Improvement in Both Groups**: Both the control group and experimental group showed improvement in mathematical problem-solving skills from pre-test to post-test.
- Control Group improved from 58.4 to 64.1 (mean gain = 5.7 points).
- Experimental Group improved from 57.9 to 74.3 (mean gain = 16.4 points).
2. **Greater Improvement in Experimental Group**: The experimental group, which was taught using constructivist approaches, showed significantly greater improvement compared to the control group, which likely followed traditional methods.
3. **Statistical Significance**:
- The calculated t-value ≈ 2.93 and p-value ≈ 0.005 indicate that the difference in improvement between the two groups is statistically significant at the 0.01 level.
- This suggests the observed difference is unlikely due to chance.
4. **Large Effect Size**:
- The Cohen's d ≈ 1.07, which indicates a large effect of the constructivist teaching strategy on mathematical problem-solving improvement.
5. **Interpretation**:
- The data suggests that constructivist teaching methods significantly enhance mathematical problem-solving skills, particularly for diverse learners, compared to traditional instruction.

2.3 Results

Table 2: Average Improvement of Pre-test vs. Post-test Scores by Experimental Group and Control Group

Group	Pre-Test Mean	Post-Test Mean	Improvement
Control	58.4	64.1	5.7
Experimental	57.9	74.3	16.4

N= 30

2.3.1Pre-Test vs Post-Test Mean Scores by Experimental group and Control group: Here's the double bar graph comparing mean pre-test and post-test scores across Control group and Experimental group.

a) The experimental groups show a clear jump in scores after the intervention, unlike the modest gains in control groups.
b) The Experimental groups had clearly significantly greater improvement than the Control groups.

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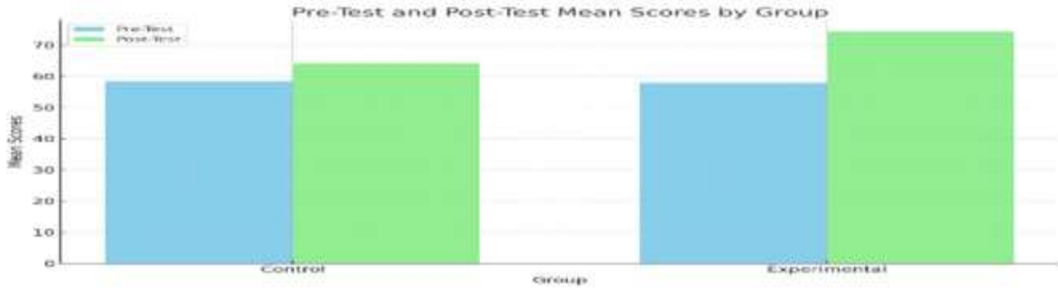

Figure 1: Bar Graph of Average Improvement between Control Group and Experimental Group

2.4 Discussion:

1. The findings of this study indicate that the study shows that constructivist teaching approaches significantly improve mathematical problem-solving skills among diverse learners, with a significantly higher mean improvement compared to traditional methods.
2. The experimental group's improvement is likely due to the constructivist approach, with a large effect size indicating its strong educational impact on learners' problem-solving performance.
3. The study supports constructivist theory, indicating that active student engagement in understanding leads to better learning outcomes, particularly for diverse learners who often struggle with rigid instruction.
4. This study highlights the importance of adapting pedagogy to accommodate diverse learners in inclusive classrooms, particularly those disadvantaged by traditional rote-learning methods. However, limitations include sample size, teaching quality, and contextual factors. Future research should include a larger, diverse sample and explore long-term retention effects.

2.5 Conclusion and Recommendations

2.5.1 Conclusion: This study shows that, particularly for diverse learners, constructivist teaching methods greatly improve students' ability to solve mathematical problems. When compared to the control group, who received instruction using conventional methods, the experimental group demonstrated significantly more improvement as a result of their active, student-centered learning through inquiry, teamwork, and real-life problem situations. The considerable effect size and statistically significant results show that constructivist practices improve academic performance while also fostering more responsive and inclusive learning environments. The results validate that teaching strategies that emphasize engagement, investigation, and conceptual understanding over rote memorization are beneficial for students with a range of learning requirements, backgrounds, and skill levels. A useful paradigm for addressing learner variety and advancing fairness in mathematics instruction is provided by constructivist pedagogy.

2.5.2 Recommendations:

1. **Include constructivist methods in the math curriculum:** Constructivist methods including inquiry-based learning, project-based assignments, and problem-solving in real-world situations should be incorporated into math curricula at educational institutions.
2. **Provide Teachers with Student-Centered, Differentiated Pedagogy Training:** Teachers must be given the knowledge and resources they need to create and carry out constructivist lessons that cater to the requirements of a diverse student body as part of professional development programs.
3. **Implement Inclusive Teaching Methods**: Teachers should use adaptable teaching strategies that give learners a variety of opportunities to interact with and show their mastery of mathematics.

4. **Enhance Constructivist Learning with Technology:** To make math education more approachable and interesting, digital tools and platforms that facilitate interactive, visual, and group learning should be used.
5. **Promote Collaborative and Reflective Learning:** In order to help students create meaning via shared experiences and viewpoints, classrooms should encourage a culture of introspection, discussion, and peer cooperation.
6. **Additional Investigations and Longitudinal Studies:** To strengthen the body of evidence, future research should examine the long-term effects of constructivist teaching on various learners in a range of academic situations and subjects.

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