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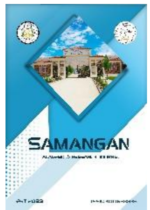

Improving Math Learning and Motivation in Disadvantaged Schools: A Case Study of Chahi-Zandan Girls' High School

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Keywords

Active mathematics teaching, collaborative learning, social cooperation, disadvantaged educational context, case study

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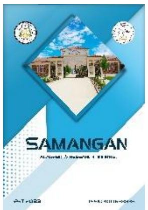
Abstract

The aim of the present study was to investigate the effectiveness of active mathematics teaching methods on different dimensions of students' learning in a low-income educational setting. This study used a quantitative descriptive approach and a case study design, and its sample consisted of 19 students from grades 4 to 7 at a school, selected through convenience sampling. Data were collected using a researcher-developed questionnaire comprising 25 items across five dimensions: motivation, understanding of concepts, social cooperation, teacher's role, and learning outcomes. The instrument's reliability was examined using Cronbach's alpha, which yielded a very desirable value of 0.938 for the entire questionnaire. Data analysis was conducted exploratorily using descriptive statistics, Pearson correlation, and simple linear regression. The study found that the mean scores across all dimensions were above the scale average, indicating students' positive attitude towards the mathematics learning experience through active teaching methods. The correlation results indicated strong, positive relationships among some dimensions, especially between understanding of concepts and learning outcomes. Also, regression analysis showed that social cooperation significantly predicted students' learning outcomes ($p = 0.008$). Overall, the results indicate that active mathematics teaching methods, even in low-resource settings, can effectively improve learning by strengthening social capital and fostering interpersonal cooperation.



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کلمات کلیدی

تدریس فعال ریاضی، یادگیری مشارکتی، همکاری اجتماعی، بستر آموزشی کم‌امکانات، مطالعه موردی.

چکیده

هدف پژوهش حاضر بررسی کارایی روش‌های فعال تدریس ریاضی بر ابعاد مختلف یادگیری شاگردان در یک بستر آموزشی کم‌امکانات بود. این پژوهش با رویکرد کمی توصیفی و مبتنی بر مطالعه موردی انجام شد و نمونه آن را ۱۹ شاگرد صنوف چهارم تا هفتم یک مکتب تشکیل دادند که به روش نمونه‌گیری در دسترس انتخاب شدند. داده‌ها با استفاده از پرسش‌نامه‌ای محقق‌ساخته شامل ۲۵ گویه در پنج بُعد انگیزه، فهم مفاهیم، همکاری اجتماعی، نقش معلم و نتایج یادگیری گردآوری شد. پایایی ابزار با استفاده از ضریب آلفای کرونباخ بررسی گردید که مقدار بسیار مطلوب ۰.۹۳۸ را برای کل پرسش‌نامه نشان داد. تحلیل داده‌ها با بهره‌گیری از آمار توصیفی، همبستگی پیرسون و رگرسیون خطی ساده به‌صورت اکتشافی انجام شد. یافته‌های پژوهش نشان داد که میانگین نمرات تمامی ابعاد بالاتر از حد متوسط مقیاس قرار دارد که بیانگر نگرش مثبت شاگردان نسبت به تجربه یادگیری ریاضی از طریق روش‌های فعال تدریس است. نتایج همبستگی حاکی از روابط مثبت و قوی میان برخی ابعاد، به‌ویژه بین فهم مفاهیم و نتایج یادگیری، بود. همچنین، تحلیل رگرسیون نشان داد که همکاری اجتماعی به طور معناداری ($p = 0.008$) نتایج یادگیری شاگردان را پیش‌بینی می‌کند. در مجموع، نتایج نشان می‌دهد که روش‌های فعال تدریس ریاضی، حتی در شرایط کم‌امکانات، می‌توانند از طریق تقویت سرمایه اجتماعی و همکاری بین‌فردی، نقش مؤثری در بهبود یادگیری ایفا کنند.

1. Introduction

Teaching mathematics in disadvantaged and underserved settings has always been associated with numerous structural and educational challenges. Research shows that lack of educational resources, socio-economic constraints, less teacher experience, and the dominance of traditional and teacher-centered methods are among the factors that reduce learning motivation and weaken mathematical conceptual understanding among students in these contexts(Foote, 2010; Kitchen et al., 2017; Tibane et al., 2024) . These conditions often lead to a decline in academic performance and a decrease in students' active participation in the mathematics teaching-learning process(Goudeau et al., 2023). In response to these challenges, the research literature over the past two decades has increasingly emphasized the use of innovative, active, and participatory teaching methods. The use of interactive and student-centered teaching methods can significantly increase motivation and conceptual understanding of mathematics, especially among disadvantaged students(Hung et al., 2015; Sari et al., 2024). These findings are supported by statistical evidence based on descriptive statistics, Pearson's correlation, and regression analyses (Lopez & Ortega-Dela Cruz, 2022). Among these methods, the Gallery Walk method is considered one of the most widely studied and effective approaches to teaching mathematics. Empirical studies show that Gallery Walk improves students' conceptual understanding, mathematical reasoning, and metacognitive skills by enhancing peer interaction, exchanging problem-solving strategies, and providing continuous feedback(Pinto & Cardoso, 2025). Also, research (Sibarani et al., 2025) showed that combining Gallery Walk with collaborative learning significantly increased students' conceptual mastery of mathematical concepts. Group work and the Group Work/Group Investigation (Juraei) method have also been introduced as among the most effective collaborative approaches in mathematics education. Research results indicate that structured teamwork can increase academic motivation, collaboration skills, and retention of mathematics learning, especially among disadvantaged students (Reinholz, 2018; Tan et al., 2007). However, the effectiveness of this method depends on factors such as group composition, the level of teacher guidance, and the use of instructional scaffolding strategies (Singh, 2007). Alongside these methods, rotational interactive approaches such as Onion Rings and Yang-based collaborative activities have also received attention. Studies show that these methods increase active participation and learner satisfaction by increasing mobility, dialogue, and social interaction, especially when localized to cultural and educational conditions (Ágnes & Ágnes, 2017; Khan, 2008). However, empirical evidence regarding the direct application of these methods in mathematics education has been reported as more limited than for Gallery Walk and Group Work (Usmadi & Ergusni, 2025). From an analytical perspective, many studies have identified learning motivation as a key mediating variable in the relationship between innovative teaching methods and mathematics academic achievement. Correlational studies indicate strong, significant relationships between motivation and mathematics performance (Hui &

Mahmud, 2023). In addition, regression results indicate that modern teaching methods often enhance students' conceptual understanding of mathematics by increasing their motivation, self-efficacy, and positive attitude (Roslita Anggraeni et al., 2024). Despite the positive results reported, research emphasizes the moderating role of contextual variables, such as socioeconomic status, gender, linguistic background, and access to technology, which can alter the intensity and direction of the effects of new teaching methods. (Jasmaniah et al., 2024; Tohani et al., 2023). Also, the lack of longitudinal studies and research on disadvantaged conditions has been identified as an important gap in the research literature (Table 1).

Table 1 presents a summary of selected key studies related to innovative teaching methods and mathematics learning.

No.	Author(s) (Year)	Teaching Method	Study Population	Research Method	Main Findings
1	(Hariyadi et al., 2023; Hung et al., 2015)	Digital Game-Based Learning (Yang-based)	Students	Quasi-experimental	Significant increase in motivation, concentration, and satisfaction in learning mathematics
2	(Ágnes & Ágnes, 2017; Tan et al., 2007)	Group Investigation	Students	Experimental	Increased motivation and social interaction; effectiveness dependent on group structure
3	(Canto López et al., 2022; Lopez & Ortega-Dela Cruz, 2022)	Gallery Walk	Secondary school students	Quasi-experimental	Improved conceptual understanding and oral explanation skills
4	(Pinto & Cardoso, 2025)	Gallery Walk	Mathematics students	Mixed-methods (Qualitative–Quantitative)	Enhanced mathematical problem-solving and metacognitive skills
5	(Sibarani et al., 2025)	Gallery Walk + Collaborative Learning	Students	Action research	Increase in conceptual mastery from 14% to 86%
6	(Reinholz, 2018)	Structured Group Work	University students	Review study	Improved learning retention and deep conceptual understanding
7	(Ágnes & Ágnes, 2017)	Onion Rings	Trainees	Descriptive–analytical	Increased learner participation and motivation

No.	Author(s) (Year)	Teaching Method	Study Population	Research Method	Main Findings
8	(Khan, 2008)	Technology-Supported Group Work	University students in developing countries	Case study	Improved interaction and reduced participation barriers
9	(Bukunola, 2012)	Motivation and Achievement Analysis	Students	Correlational	Strong positive relationship between motivation and mathematics performance
10	(Amirseit et al., 2024)	Motivation Mediation Model	Students	Regression analysis	Motivation plays a mediating role in the effect of teaching methods on academic achievement

2. Materials and Methods

2.1 Research Design

The present study employed a **quantitative, exploratory case-based design** to investigate students' perceptions of active mathematics teaching methods in a low-resource educational context. The selection of this design was appropriate given the study's aim to provide an in-depth understanding of learning experiences within a specific educational setting rather than to produce statistically generalizable findings.

Given the contextual constraints and exploratory nature of the research, the study focuses on identifying patterns and relationships among key learning dimensions rather than establishing causal inferences.

2.2 Research Context

The study was conducted in a **low-resource educational environment** where teaching was primarily supported by basic instructional materials such as charts, markers, and handwritten content. Advanced technological resources (e.g., smart boards, digital learning tools) were not available.

Within this context, **active and participatory teaching methods**—including Gallery Walk, group work, onion-ring activities, and collaborative learning strategies—were systematically implemented in mathematics classes. This setting provided a suitable natural environment for examining the effectiveness of interaction-based teaching approaches under resource constraints.

2.3 Participants and Sampling

The statistical population consisted of students from **grades 4 to 7**. Due to practical and contextual limitations, a **convenience sampling method** was employed. A total of **19 students** who were actively engaged in classrooms using active teaching methods participated in the study.

Although the sample size is limited, it is considered acceptable within the framework of an **exploratory case study**. However, it is important to note that the findings should be interpreted as **context-specific and not generalizable** to broader populations. The primary objective of this study is to provide preliminary empirical insights rather than definitive conclusions.

2.4 Data Collection Instrument

Data were collected using a **researcher-developed questionnaire** designed to assess students' perceptions of active mathematics teaching methods. The instrument consisted of **25 items** measured on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire was structured into five key dimensions:

1. Motivation
2. Conceptual Understanding
3. Social Cooperation
4. Teacher Role
5. Learning Outcomes

The instrument's design was informed by the existing literature on **active learning and collaborative pedagogy**, ensuring alignment with theoretical constructs relevant to mathematics education.

2.5 Validity of the Instrument

To ensure the instrument's validity, face and **content validity** were established. Face validity focused on clarity, simplicity, and appropriateness of the items for students at the primary education level. Content validity was assessed through expert review by specialists in education and teaching methodologies. Although **construct validity (e.g., factor analysis)** was not conducted due to the limited sample size, the instrument was developed based on established theoretical frameworks and prior empirical studies, which support its conceptual validity.

2.6 Reliability of the Instrument

The reliability of the instrument was assessed using **Cronbach's alpha coefficient** to evaluate internal consistency. The questionnaire's overall reliability was **α = 0.938**, indicating a very high level of internal consistency. Reliability was also examined for each dimension individually. While most dimensions demonstrated acceptable to strong reliability levels, the teacher role dimension showed relatively lower reliability. However, given the exploratory nature of the study and the limited sample size, the instrument was considered sufficiently reliable for subsequent analyses.

2.7 Data Analysis

Data were analyzed using **Python-based statistical procedures** at two levels:

2.8 Descriptive Analysis

Descriptive statistics—including mean, standard deviation, minimum, and maximum values—were calculated to summarize students' responses and identify general trends across the five dimensions.

2.9 Correlation Analysis

Pearson's correlation coefficient was used to examine the relationships between the study variables. The results were interpreted as **associative rather than causal relationships**.

2.10 Exploratory Regression Analysis

A simple linear regression analysis was conducted in an exploratory manner to identify potential predictive relationships among selected variables.

Given the limited sample size, the use of more advanced statistical techniques (e.g., structural equation modeling) was not appropriate. Therefore, the regression results should be interpreted with caution and as an exploratory analysis.

2.11 Conceptual Model

Based on the theoretical framework and observed statistical patterns, a **conceptual path model** was developed to provide an interpretive explanation of the relationships among variables (Figure 1). This model is not statistical in nature but serves as a **theoretical framework** for understanding how active teaching methods may influence learning outcomes through motivational and social mechanisms.

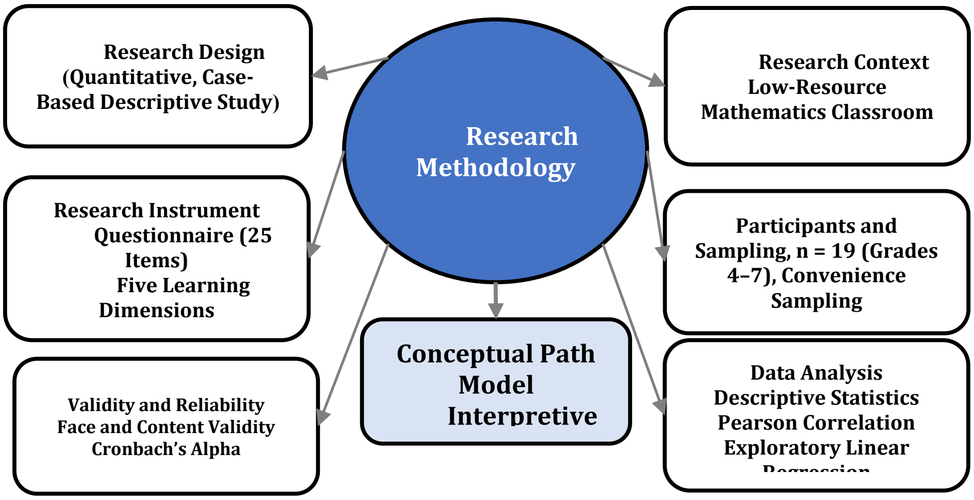

Figure 1. Research methodology flowchart illustrating the study design, research context, participants and sampling, research instrument, validity and reliability procedures, data analysis methods, and the development of the interpretive conceptual path model.

3. Results

In this study, data were collected from 19 fourth- to seventh-grade students enrolled in a low-resource educational setting (Table 1). All participants attended classes that used active mathematics teaching methods, including Young's method, onion rings, gallery walks, and group/pair work. The educational setting lacked advanced facilities, and the teaching process was mainly conducted with simple tools.

Table 1. Characteristics of the Participants

Variable	Category	n	%
Grade level	Grades 4–7	19	100
Gender	Male	19	100
Learning context	Low-resource classroom	19	100
Teaching methods used	Active methods	19	100

This homogeneity of the educational context allowed us to focus on analyzing the students' learning experience within the framework of a case study.

3.1. Descriptive statistics of the research dimensions

To examine the overall state of students' views on active mathematics teaching methods, descriptive statistics were calculated for the five research dimensions (Table 2). The results showed that the mean scores across all dimensions were above the midpoint of the five-point Likert scale, indicating a positive attitude of students towards the mathematics learning experience in these teaching methods.

Table 2. Descriptive Statistics of Study Dimensions

Dimension	n	Mean	SD
Motivation	19	4.39	0.99
Concept Understanding	19	4.46	0.85
Social Cooperation	19	4.41	0.80
Teacher Role	19	4.52	0.87
Learning Outcomes	19	4.42	0.83

Among the research dimensions, the teacher's role had the highest average, indicating that students very positively assessed the way the teacher guided, supported, and facilitated the implementation of active teaching methods in low-resource conditions. After that, the dimensions of understanding mathematical concepts and social cooperation also showed high averages, indicating a favorable understanding of the course concepts and an appropriate level of student interaction and participation in group activities.

The dimensions of motivation and learning outcomes were also at a favorable level, indicating that students generally had a positive learning experience in this educational framework.

3.2. Reliability of the research instrument

The questionnaire's reliability was examined using Cronbach's alpha. The results showed that the Cronbach's alpha for the entire instrument was 0.938, indicating very high reliability (Table 3). Also, the Cronbach's alpha coefficients for the dimensions of motivation, understanding concepts, social cooperation, and learning outcomes were at a good to very good level.

Table 3. Reliability Analysis (Cronbach's Alpha)

Dimension	Items	Cronbach's α
Motivation	5	0.886
Concept Understanding	5	0.881
Social Cooperation	5	0.848
Teacher Role	5	0.667
Learning Outcomes	5	0.906
Overall scale	25	0.938

Although the Cronbach's alpha value for the teacher role dimension was reported to be at a borderline acceptable level, due to the limited number of items and sample size, this value was still considered usable for subsequent analyses. In order to improve the accuracy of the analysis, the alpha index is performed when the item is removed (Item-Total Statistics) and the results are shown in Figure 2.

A more detailed analysis of the items (Item-Total Statistics) showed that, in the teacher role dimension, item 23 has a weak correlation with the total score for this dimension. The findings indicate that removing this item increases Cronbach's alpha for the teacher role from 0.66 (Table 3) to 0.71 (Figure 2). However, because the theoretical structure of the instrument was preserved, all items were used in subsequent analyses.

3.3. Correlation analysis between research dimensions

To examine the relationships among the research dimensions, the Pearson correlation coefficient was used. The results showed that there are positive relationships of varying intensities among most dimensions. The strongest correlation was between understanding mathematical concepts and learning outcomes, indicating a close relationship between a deep understanding of the subject concepts and students' learning outcomes. Also, the very strong correlation between social cooperation and the teacher's role indicates the importance of educational interactions and effective teacher guidance in enhancing student participation in learning activities (Table 4).

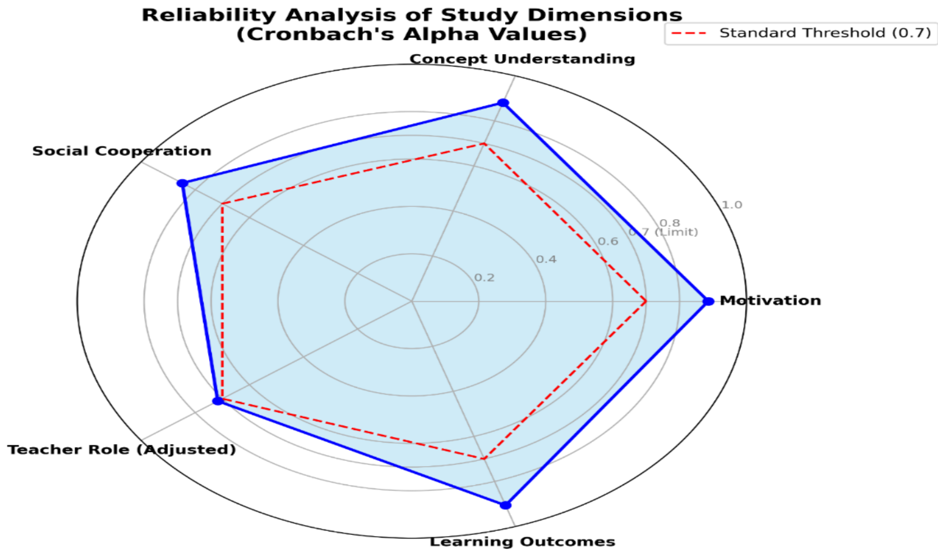

Figure 2. Radar chart illustrating the internal consistency (Cronbach's Alpha) of the five study dimensions. The red dashed line represents the acceptable reliability threshold (0.70).

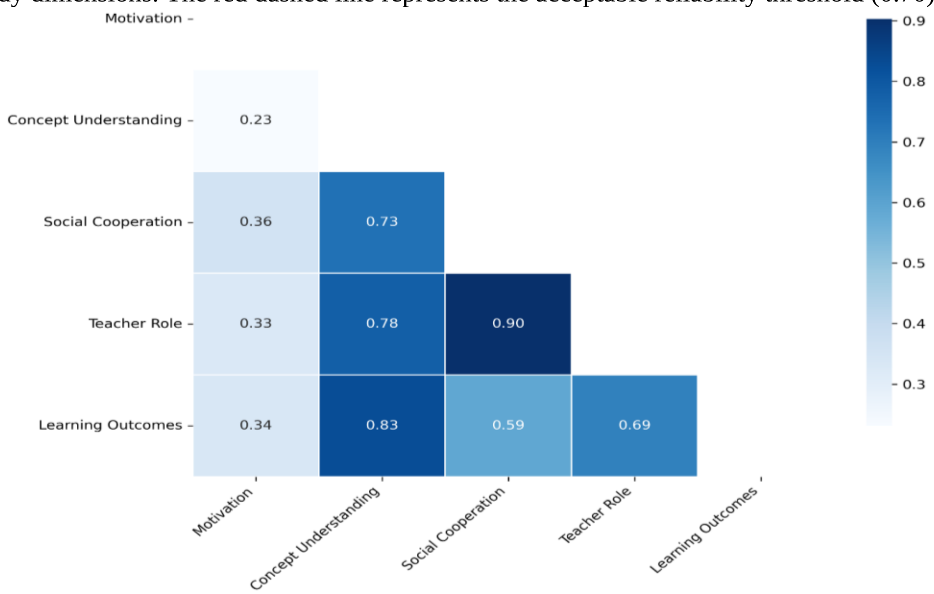

Figure 3 . Heatmap of Pearson correlation coefficients between study dimensions. The color intensity and numerical values represent the strength of the relationship between variables.

The relationships between understanding concepts through social collaboration and the teacher's role were also relatively strong, indicating the simultaneous roles of teacher-teaching strategies and social interactions in improving understanding of mathematical concepts. In contrast, the relationships within the motivation dimension were weak to moderate. It is important to emphasize that these relationships indicate only a statistical association between the variables, and causal inferences should not be made from them.

Table 4. Pearson Correlation Matrix Between Study Dimensions

Dimension	Motivation	Concept Understanding	Social Cooperation	Teacher Role	Learning Outcomes
Motivation	1.00	0.23	0.36	0.33	0.34
Concept Understanding	0.23	1.00	0.73	0.78	0.83
Social Cooperation	0.36	0.73	1.00	0.90	0.59
Teacher Role	0.33	0.78	0.90	1.00	0.69
Learning Outcomes	0.34	0.83	0.59	0.69	1.00

3.4. Exploratory Predictive Analysis

To examine possible predictive patterns among some research variables, a simple linear regression analysis was conducted exploratively. The results showed that among the models examined, only social cooperation significantly predicted students' learning outcomes. This finding indicates that increasing students' interaction and participation in group activities can improve their learning outcomes. In contrast, the teacher's role as a predictor of motivation and motivation as a predictor of understanding of concepts failed to show significant predictive relationships. These results indicate that although there are relationships among these variables, their strength was insufficient for statistical prediction. Given the limited sample size, the results of this analysis should be interpreted with caution.

3.5. Conceptual Pathway Model of the Research

Based on the research's theoretical framework and the overall pattern of findings, a conceptual path model was presented to explain the relationships among variables (Figure 5). This model shows that active mathematics teaching methods can, through mediating variables such as motivation and especially social cooperation, lead to improved understanding of concepts and ultimately to improved student learning outcomes. It should be noted that this model is not statistical in nature and is presented solely as an interpretive framework to better understand the research results.

Table 5. Exploratory Simple Regression Results

Model	Predictor	Outcome	β	R^2	p-value
1	Teacher Role	Motivation	0.45	0.11	0.168
2	Motivation	Concept Understanding	0.19	0.05	0.341
3	Social Cooperation	Learning Outcomes	**0.63**	**0.35**	**0.008**

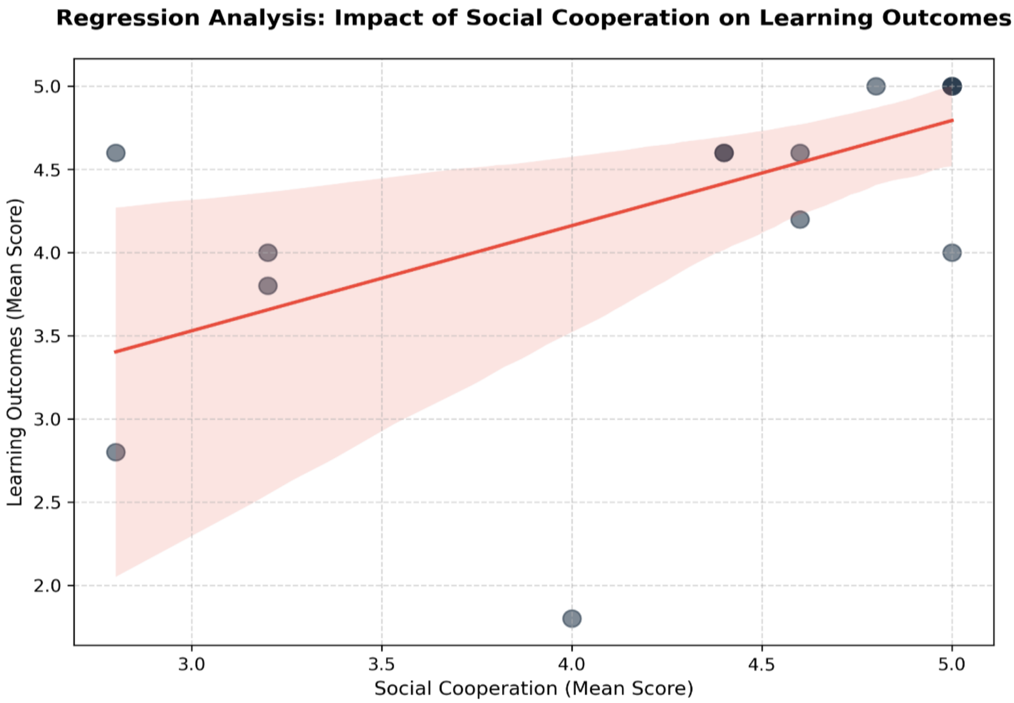

Figure 4. Linear regression plot showing the significant predictive relationship between Social Cooperation and Learning Outcomes $(p < 0.01)$.

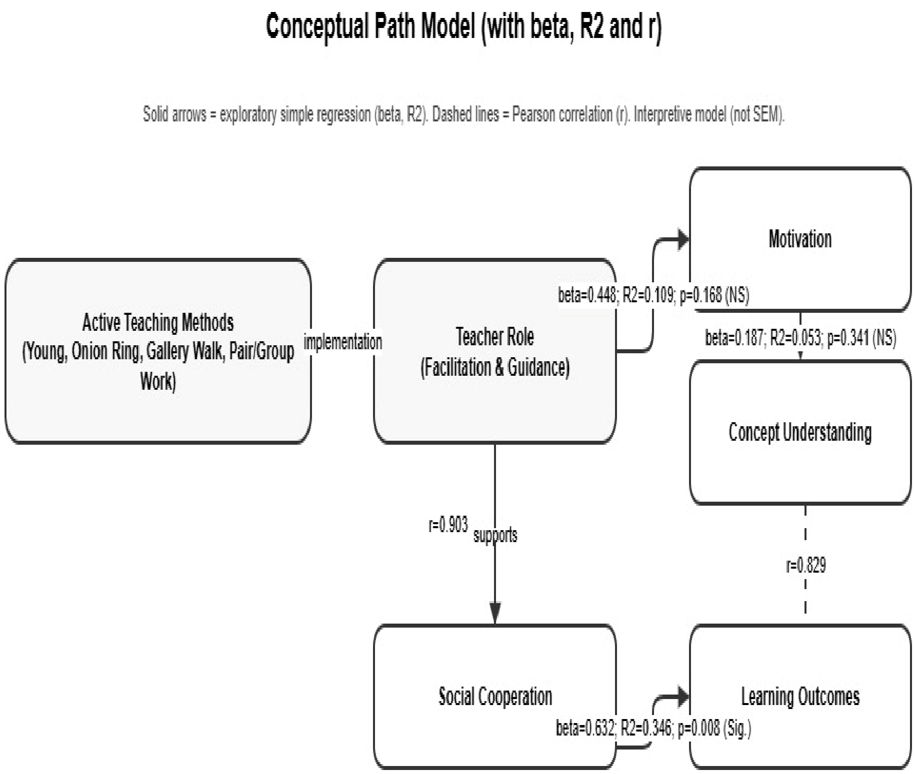

Figure 5 . Conceptual model illustrating how active teaching may influence learning outcomes via motivational and social mechanisms in a low-resource classroom context.

The path model (Figure 5) serves as a conceptual framework for understanding the interactions between variables. This model suggests that although there are multiple paths, the social-participatory dimension is the strongest predictor of academic success in resource-limited settings.

4. Discussion and Interpretation of Findings

The present study aimed to examine the effectiveness of active mathematics teaching methods in a low-resource educational setting. The findings of this case-based study provide meaningful insights into how interactive and participatory teaching approaches influence different dimensions of student learning. In this section, the results are interpreted with direct reference to the statistical findings presented in Tables 2–5 and Figures 2–5.

4.1 Interpretation of Descriptive Findings

Based on the descriptive statistics presented in **Table 2**, the mean scores of all five dimensions—motivation, conceptual understanding, social cooperation, teacher role, and learning outcomes—were above the midpoint of the Likert scale. This indicates that students had a generally positive perception of their mathematics learning experience through active teaching methods.

Among these dimensions, the **teacher role** demonstrated the highest mean score (M = 4.52; Table 2), highlighting the crucial importance of teacher guidance and facilitation in low-resource environments. This finding suggests that, in the absence of advanced educational tools, the effectiveness of the learning process depends largely on the teacher's ability to organize, guide, and support classroom activities.

Similarly, relatively high mean values for **conceptual understanding (M = 4.46)** and **social cooperation (M = 4.41)** (Table 2) indicate that active teaching methods have contributed to both improved comprehension of mathematical concepts and increased student interaction. These findings reinforce the idea that **social and instructional dynamics can compensate for limited material resources**.

4.2 Reliability of the Instrument and Measurement Consistency

The reliability analysis results presented in **Table 3** indicate that the questionnaire's overall internal consistency was very high (Cronbach's α = 0.938), suggesting that the instrument was reliable for measuring the intended constructs.

While most dimensions demonstrated acceptable to strong reliability levels, the **teacher role dimension showed a relatively lower alpha value (α = 0.667; Table 3)**. A more detailed item-level analysis (Figure 2) revealed that removing item 23 increased the dimension's reliability to 0.71.

This finding may reflect the transitional nature of the teacher's role in active learning environments, where students may still be adapting to a shift from traditional teacher-centered instruction to a facilitative teaching approach. Despite this limitation, the overall reliability results support the validity of the subsequent analyses.

4.3 Relationships Between Learning Dimensions

The results of the Pearson correlation analysis (**Table 4**) indicate positive relationships among most of the study variables, with varying strengths.

The **strongest correlation was observed between conceptual understanding and learning outcomes (r = 0.83; Table 4)**, suggesting that students who develop a deeper understanding of mathematical concepts tend to achieve better learning outcomes. This relationship is also visually supported by the heatmap in Figure 3, where the association is represented by higher-intensity values.

In addition, a very strong correlation was found between **social cooperation and teacher role (r = 0.90; Table 4)**. This result indicates that effective teacher facilitation plays a key role in promoting student interaction and collaborative learning. The visual representation in **Figure 3** further confirms the strength of this relationship.

The relationships between conceptual understanding and both **social cooperation (r = 0.73)** and **teacher role (r = 0.78)** (Table 4) also suggest that meaningful learning occurs through a combination of instructional guidance and peer interaction.

In contrast, the correlations involving **motivation** were relatively weaker (Table 4), indicating that motivation may function as a supporting or indirect variable rather than a central determinant in this context.

4.4 Interpretation of Exploratory Predictive Findings

The results of the exploratory regression analysis (**Table 5**) revealed that among the examined models, only **social cooperation significantly predicted learning outcomes ($\beta = 0.63$, $R^2 = 0.35$, $p = 0.008$)**. This relationship is also illustrated in **Figure 4**, which shows a clear positive linear trend between these variables.

This finding highlights the central role of **collaborative learning and student interaction** in improving academic performance. It suggests that students who actively engage in group activities, discussions, and peer problem-solving are more likely to achieve better learning outcomes.

In contrast, other regression models—such as teacher role predicting motivation and motivation predicting conceptual understanding—were not statistically significant (Table 5). These non-significant findings may be attributed to the **limited sample size**, which reduces statistical power, or to the possibility that these variables operate indirectly within the learning process.

Overall, these results emphasize that **social cooperation is the most influential factor** in explaining learning outcomes within this specific educational context.

4.5 Interpretation of the Conceptual Model

Based on the overall pattern of findings from descriptive, correlational, and regression analyses (Tables 2–5), the conceptual model presented in **Figure 5** provides an interpretive framework for understanding the relationships among variables.

The model suggests that active teaching methods influence learning outcomes primarily through **social cooperation**, with conceptual understanding and motivation acting as supporting mechanisms.

It is important to note that this model is not statistically tested but is developed as a **theoretical interpretation** of the observed data patterns. Nevertheless, it offers a coherent explanation of how interactive teaching approaches function in low-resource settings.

4.6 Limitations and Suggestions for Future Research

Despite the meaningful findings, this study's results should be interpreted in light of several limitations. The limited sample size and focus on a specific educational setting limit the generalizability of the results. Also, the use of self-report data may be associated with response bias. It is suggested that future studies with larger samples, quasi-experimental designs, and the use of mixed (quantitative-qualitative) data statistically test the conceptual model presented in this study (Figure 1).

5. Conclusion

This study showed that using active teaching methods in a low-resource educational setting is not only possible but can also lead to a significant improvement in students' learning experience. Statistical findings and predictive analyses (especially regression models and conceptual path models) indicate that the quality of classroom interactions, especially social cooperation, plays a key role in explaining learning outcomes. This shows that in deprived educational settings, the effectiveness of mathematics education is influenced by how participatory activities are organized and by the teacher's ability to facilitate an interactive environment, rather than by advanced educational facilities and technology. In fact, this study proved that "social interaction" can act as a source of compensation for the lack of material facilities. Despite limitations, including sample size, this study provides valuable evidence that can serve as a basis for educational policies promoting student-centered approaches in underserved areas.

References

Ágnes, C., & Ágnes, G. (2017). Motiválás, ösztönzés a szakképzésben: Egyes pedagógiai eszközök ösztönzőerejének tanulói megítélése társadalmi háttérváltozóik szerint. *Szociologiai Szemle*, *27*(1).

Amirseit, U., Bakbergen, S., Temirkhan, A., & Bassygarayev, Z. (2024). Evaluation of the effectiveness of innovative methods in biology teaching. *BIO Web of Conferences*, *100*, 01004. https://doi.org/10.1051/bioconf/202410001004

Bukunola, B.-A. (2012). Effectiveness of Cooperative Learning Strategies on Nigerian Junior Secondary Students' Academic Achievement in Basic Science. *British Journal of Education, Society & Behavioural Science*, *2*(3). https://doi.org/10.9734/bjesbs/2012/1628

Canto López, M. del C., Manchado Porras, M., Piñero Charlo, J. C., Mera Cantillo, C., Delgado Casas, C., Aragón Mendizábal, E., & García Sedeño, M. A. (2022). Description of Main Innovative and Alternative Methodologies for Mathematical Learning of Written Algorithms in Primary Education. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.913536

Foote, M. Q. (2010). Mathematics teaching and learning in K-12: Equity and professional development. In *Mathematics Teaching and Learning in K-12: Equity and Professional Development*. https://doi.org/10.1057/9780230109889

Goudeau, S., Sanrey, C., Autin, F., Stephens, N. M., Markus, H. R., Croizet, J. C., & Cimpian, A. (2023). Unequal Opportunities From the Start: Socioeconomic Disparities in Classroom Participation in Preschool. *Journal of Experimental Psychology: General*, *152*(11). https://doi.org/10.1037/xge0001437

Hariyadi, S., Nugraheni, E., Antika, E., & Afriwilda, M. (2023). How common Is online game use addiction? a prevalence and motives study among undergraduate students. *European Journal of Psychological Research*, *10*(4).

Hui, H. B., & Mahmud, M. S. (2023). Influence of game-based learning in mathematics education on the students' cognitive and affective domain: A systematic review. In *Frontiers in Psychology* (Vol. 14). https://doi.org/10.3389/fpsyg.2023.1105806

Hung, C.-Y., Sun, J. C.-Y., & Yu, P.-T. (2015). The benefits of a challenge: student motivation and flow experience in tablet-PC-game-based learning. *Interactive Learning Environments*, *23*(2), 172–190. https://doi.org/10.1080/10494820.2014.997248

Jasmaniah, J., Nurhayati, N., & Zuhra, F. (2024). Game-Based Learning Model with A Culturally Responsive Teaching Approach to Enhance Student' Motivation in Learning Mathematics. *Jurnal Ilmiah Sekolah Dasar*, *8*(4). https://doi.org/10.23887/jisd.v8i4.86595

Khan, H. U. (2008). Using technological tools to solve group work problems in higher education of under developing countries: A case study. *14th Americas Conference on Information Systems, AMCIS 2008, 1*.

Kitchen, R. S., DePree, J., Celedón-Pattichis, S., & Brinkerhoff, J. (2017). Mathematics Education at Highly Effective Schools That Serve the Poor: Strategies for Change. In *Mathematics Education at Highly Effective Schools that Serve the Poor: Strategies for Change*. https://doi.org/10.4324/9781315091358

Lopez, M. K. R. R., & Ortega-Dela Cruz, R. A. (2022). Gallery Walk technique in enhancing reading comprehension and oral English language proficiency of junior high school students. *Waikato Journal of Education*, *27*(3). https://doi.org/10.15663/wje.v27i3.813

Pinto, H., & Cardoso, N. (2025). The Gallery Walk in the Didactics of Mathematics. *AIP Conference Proceedings*, *3315*. https://doi.org/10.1063/5.0286072

Reinholz, D. L. (2018). A Primer on Small Group Instruction in Undergraduate Mathematics. *PRIMUS*, *28*(10). https://doi.org/10.1080/10511970.2018.1471632

Roslita Anggraeni, Daffa Aulia Rahmadanti, Ratna Dwi Aryanti, Azizah Syifa Az Zahra, Fina Fakhriyah, & Nur Fajrie. (2024). Systematic Literature Review: Peningkatan Kemampuan Literasi Numerasi Siswa SD Melalui Pendekatan Media Pembelajaran Berbasis Game. *Intellektika : Jurnal Ilmiah Mahasiswa*, *2*(5). https://doi.org/10.59841/intellektika.v2i5.1483

Sari, S., Elniati, S., Martin, S. N., & Rusyda, N. A. (2024). Game-based learning approach on students' motivation in mathematics learning: A systematic review of literature. *AIP Conference Proceedings*, *3024*(1). https://doi.org/10.1063/5.0204414

Sibarani, S., Tampubolon, T., & Harianja, R. (2025). The application of the cooperative learning model group investigation type is complemented by a gallery walk to improve understanding of mathematical concepts in quadrilateral material. *AIP Conference Proceedings*, *3038*(1), 020030. https://doi.org/10.1063/5.0254551

Singh, P. (2007). Using action research to improve communication and facilitate group work in a multicultural classroom: A South African case study. *Systemic Practice and Action Research*, *20*(4). https://doi.org/10.1007/s11213-006-9063-z

Tan, I. G. C., Lee, C. K. E., & Sharan, S. (2007). Group investigation effects on achievement, motivation, and perceptions of students in Singapore. *Journal of Educational Research*, *100*(3). https://doi.org/10.3200/JOER.100.3.142-154

Tibane, C. C., Mafa-Theledi, O. N., Masebe, T. P., & Mathye, P. (2024). Examining the Effect of Resource Constraints on Teaching and Learning of Grade 12 Mathematics in Gauteng Community Learning Centres. *International Journal of Learning, Teaching and Educational Research*, *23*(10). https://doi.org/10.26803/ijlter.23.10.22

Tohani, E., Wibawa, L., & Prasetyo, I. (2023). The Performance of Internal Quality Assurance of Community Learning Centers during the Covid-19 Outbreak. *Journal of Intercultural Communication*, *23*(3). https://doi.org/10.36923/jicc.v23i3.126

Usmadi, & Ergusni. (2025). Innovative Pedagogical Models in Mathematics Education: A Systematic Review of Global Challenges, Trends, and Future Research Directions. *International Journal of Learning, Teaching and Educational Research*, *24*(9). https://doi.org/10.26803/ijlter.24.9.9