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Utilization of Cooperative Teaching Strategy Through Diverse Grouping Techniques to Enhance Numeracy Outcomes

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Abstract. The study examined the effectiveness of grouping techniques in a cooperative teaching strategy to enhance the performance of Grade 9 learners in Mathematics at Francisco Alindogan National High School (FANHS) during the School Year 2023-2024. The study specifically sought to (1) collect and summarize the pretest and post-test mean scores of the experimental and control groups, (2) find the differences in mean scores of each group in the pretest and post-test, (3) identify which group obtained the most significant mean gain, and (4) determine the significant differences among the mean gain scores of experimental and control groups. This quasi-experiment involves sixty (60) Grade 9 learners from two intact classes divided into three main groups through stratified random sampling: the Grading Scale Group, the Learning Style Group, and the Control Group, with equal replications. The experimental and control groups are exposed to face-to-face classes using the 5E lesson delivery model. Their performance is based on the pretest-posttest results of the Albay Numeracy Assessment Tool (ALNAT). The calculated $F(2, 12) = 4.24$, $p = 0.0405$, exceeds the tabulated value of 3.89 at (2, 12), showing that at least two of the means are significantly different from each other using the analysis of variance (ANOVA) at alpha (α) = 0.05 level of significance. Of the three grouping schemes, the Learning Style group showed the most significant mean gain. This outcome supports the idea that organizing learners heterogeneously by learning style will result in versatile groups that can accommodate varied instructional challenges in a cooperative teaching strategy. Thus, higher mathematics performance is achieved.

Keywords: Cooperative teaching; Heterogeneous grouping; Learning style; Mathematics performance.

1.0 Introduction

A region-wide assessment—the Albay Numeracy Assessment Tool (ALNAT) Posttest, School Year 2022-2023—conducted at Francisco Alindogan National High School revealed that out of 108 grade 9 examinees, only 27 (20.93%) reached the passing numeracy skill level (≥75%). With this result, it is imperative to tailor a mathematics intervention to elevate learners' academic achievement by refining instructional delivery. This study sought to answer this by incorporating a cooperative teaching strategy with diverse grouping techniques.

As Philippine education returns to normal after the pandemic, strategic teaching interventions are highly beneficial to address the needs of learners who have experienced learning losses and gaps, especially in mathematics. Studies suggest that there are likely greater losses in mathematics than in English Language Arts

(ELA), but mathematics is potentially more responsive to intervention. Allensworth (2020) emphasized that there is greater variation in mathematics in terms of learning growth and sensitivity. By implementing practical teaching methods, strategies, and approaches for every lesson and competency, the school is expected to educate learners effectively and yield positive results. Often, teachers closely follow procedures outlined in teaching guides during lesson delivery. Lessons frequently involve cooperative and collaborative learning, particularly in mathematics and science. Learners are typically grouped randomly using various methods (e.g., counting, sectors, rows) or by teacher selection and student choice. The learners in groups complete tasks and report their outputs to the class. This practice has been consistent throughout the Junior High School years. To facilitate the members' learning in a cooperative learning environment, the groups should be structured (Ballantine & Larres, 2007). Frykedal *et al*. (2022) reinforced this idea. An effective collaborative learning environment depends heavily on its structured components. Their findings show that the straightforward implementation of cooperative learning's five essential elements—positive interdependence, individual accountability, promotive interaction, social skills, and group processing—is directly linked to higher levels of student engagement across cognitive, emotional, and behavioral dimensions. Similarly, García-González *et al*. (2023) found that a highly structured framework (which implies greater attention to group structure, roles, interactions, etc.) significantly improved prosocial behaviors among younger adolescents.

Many educators widely regard cooperative learning as a practical approach to mathematics education. Aziz and Hossain (2010) found significant effects of cooperative learning compared to conventional teaching, and Terwel (2011) concluded that cooperative learning and guided co-construction are practical instructional approaches in mathematics. Lerkkanen *et al*. (2024) strongly support Terwel's (2011) core premise by confirming the effectiveness of collaborative learning (a core element of cooperative learning) and its impact on knowledge construction and mathematics achievement. Ridwan and Hadi (2022) found a significant effect supporting cooperative learning in mathematics outcomes compared to conventional learning. As an intervention, it should address individual learners' needs and challenges, help them catch up and regain lost knowledge, bridge gaps, and enhance performance by working in small groups that foster social interaction. Berger and Palomares (2011) noted that social interaction is purposeful and a tool to achieve specific goals. Decristan *et al*. (2023) noted that as students engage, they learn more, and the interactions become purposeful.

A well-planned grouping design is essential to address the individual needs of group members, taking into account various factors that influence their understanding of the lesson. By utilizing diverse grouping techniques, teachers can group the learners heterogeneously. This grouping scheme will leverage students' strengths and perspectives, enhancing collaboration, critical thinking, and learning outcomes while maintaining equity and inclusion. Singh and Agrawal (2011a) suggested that cooperative learning groups should be heterogeneous when possible. In mathematics, students in heterogeneous groups had better results than those in homogeneous groups (Černilec *et al*., 2023a). Learning style preference, for one, as a moderator variable had a causal effect on achievement in mathematics (Sriphai *et al*., 2011a). The interaction between learning style and personality characteristics significantly influenced students' mathematics problem-solving skills (Safira *et al*., 2025). Though the auditory learning style was most preferred, the kinesthetic learning style showed a significant relationship with higher math achievement (Autida, 2024). As a group, accountability speaks not just for oneself but also to peers. Accountability motivates students to stay on track, complete assignments on time, and actively participate in group activities. It helps students to benefit more, e.g., by encouraging contribution and interaction (Trisnawati, 2016).

2.0 Methodology

2.1 Research Design

This study is quasi-experimental research employing a pretest-posttest control group design. Quasi-experiment for the fact that learners in the school setting are intact upon enrolment, thus, complete randomization is not feasible. In the pretest-posttest control group design, the measurements are taken before and after the intervention for both the experimental and control groups. The pretest measurements provide a baseline for the outcome variable, namely the participants' scores. The pretest offers more precise data on the relationship between the independent and dependent variables by assessing the initial equivalence of the experimental group. The pretest–posttest design shows baseline equivalence and control for initial differences (Alessandri et al., 2017). After the intervention, the participants' performance is compared using posttest scores. The significance or non-significance of the change in scores served as the basis for causal inference. The posttest data were collected during the third and fourth quarters of the 2023–2024 school year, following the intervention.

Experimental	O_1	X_1	O_4
	O_2	X_2	O_5
Control	O_3	X_3	O_6

Where:

O_1, O_2, and O_3 – Observations 1, 2, and 3 were the Pre-tests
X_1 – Learning Style Grouping
X_2 – Grading Scale Grouping
X_3 – Random Grouping
O_4, O_5, and O_6 – Observations 4, 5, and 6 were the Post-test

Figure 1. *Research Design*

2.2 Research Participants and Sampling Technique

This study was conducted at Francisco Alindogan National High School, a complete secondary school offering both Junior High School (Grades 7-10) and Senior High School (Grades 11 and 12) programs, located at Poblacion, Batuan, Masbate (Ticao Island) under the Schools Division of Masbate Province. This study involved two intact Grade 9 classes with thirty-two (32) students from Section Zeus and twenty-eight (28) from Section Athena, totalling sixty (60) participants. They are divided into subgroups based on grading scale descriptors (Outstanding, Very Satisfactory, Satisfactory, and Fairly Satisfactory) and learning styles (Visual, Auditory/Aural, Read/Write, and Kinesthetic) through stratified random selection to obtain the desired heterogeneous experimental groups. The remaining participants served as the control and were also randomly selected to form their respective groups. Each group is composed of four (4) members.

2.3 Research Instrument

Two instruments were utilized to facilitate the participants' partial randomization and appropriate grouping. As for the basis of grades, the researcher used the Learner Progress Report Card (SF 9). The participants' academic grades in Mathematics for the first quarter were summarized and analyzed according to the grading scale descriptors as provided by DepEd Order No. 8, s. 2015. The descriptors are used to identify and group participants based on their prior performance, serving as one of the criteria for their differentiated grouping. Participants in this group were heterogeneously grouped based on the descriptor. Another is the use of the VARK Questionnaire, for which the Rasch model fitted the responses, confirming the internal validity of the four sub-constructs supporting the suitability and reliability of the instrument (Fitkov-Norris & Yeghiazarian, 2015). It is a learning-style assessment tool used to identify and group participants according to their learning styles.

For performance measurement, the Albay Numeracy Assessment Tool Pretest (Set A) and Posttest (Set B) were utilized. The ALNAT pretest-posttest competencies and skills covered in the study are the third and fourth quarters of Mathematics 9's Most Essential Learning Competencies (MELCs). The ALNAT test items from these two quarters include numbers 28 to 50, comprising a 23-item test for both Set A (pretest) and Set B (posttest) questionnaires. The pretest and posttest scores served as the sources of baseline and endline data for comparison and analysis. ALNAT is a regionally utilized numeracy assessment tool in Bicol Region validated by the University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED) High School and Elementary Mathematics Departments for test items and Bicol University College of Education's (BUCE) dean and team of Mathematics faculty to ensure the test's accuracy, social content, and language appropriateness (DepEd Albay ALNAT Manual, 2022).

2.4 Data Gathering Procedure

The initial data collection was conducted during the first and second quarters of the 2023-2024 school year, including pretest results, learners' first-quarter grades, and the learning style inventory. The pretest was administered during the second week of the school year, starting in September 2023. Both the first-quarter grades and the learning styles inventory assessment were collected and administered during the first four weeks of the second quarter. The results served as the basis for their heterogeneous grouping, in which each group in the setup contains at least three of the four passing grade descriptors or VARK learning styles. The posttest was administered on the third week of May 2024 (4th quarter). The learners' mean gain scores for the covered items in the pretest and posttest will be compared and analyzed to serve as the basis for their performance.

2.5 Data Analysis Procedure

To determine the level of significance, the means and the mean gains are compared. For both the experimental and control groups, the mean scores describe the pretest and posttest results for each group. To compute the group means of the subgroups under a particular grouping technique, the individual raw scores of group members are averaged. The mean gain scores define the difference between the pretest and posttest mean scores of each grouping scheme. After summing the individual scores for all members in each grouping scheme, the total is divided by the frequency of each grouping scheme. This process is done for both the pretest and posttest scores. Then, the pretest means are subtracted from the posttest means for each grouping technique. This results in the group mean gain.

Since this study involved three groups of participants, the researchers used ANOVA (Analysis of Variance) to determine the effects of the applied grouping techniques on students' mathematics learning outcomes. This test helps determine whether the groups differ (Moore *et al*., 2003). One-way analysis of variance is used to determine the significance of the effects of the three grouping techniques. For hypothesis testing, an alpha (α) = 0.05 level was used.

2.6 Ethical Considerations

Before the conduct of the study, an approved letter request addressed to the Schools Division Superintendent was sought, and a copy was furnished and received by the office of the school principal. The personal, sensitive, and privileged data used/obtained from the study were handled with utmost care and confidentiality in conformity with the requirements of the Philippine Data Privacy Act of 2012.

3.0 Results and Discussion

3.1 Pretest and Posttest Results of All Groups

Table 1 reflects the mean scores for both pretest and posttest of all the groups with four (4) members each under their respective grouping techniques as applied to determine their effect on their achievement.

Table 1. *Mean Scores of Experimental and Control Groups in Pretest and Posttest in ALNAT*

		Pretest		Posttest	
Groups	***N***	***X***	***M***	***X***	***M***
Grading Scale 1	4	21	5.25	43	10.75
Grading Scale 2	4	29	7.25	31	7.75
Grading Scale 3	4	32	8.00	39	9.75
Grading Scale 4	4	21	5.25	30	7.50
Grading Scale 5	4	21	5.25	32	8.00
Learning Style 1	4	35	8.75	43	10.75
Learning Style 2	4	25	6.25	51	12.75
Learning Style 3	4	20	5.00	55	13.75
Learning Style 4	4	23	5.75	33	8.25
Learning Style 5	4	20	5.00	31	7.75
Control 1	4	32	8.00	32	8.00
Control 2	4	31	7.75	26	6.50
Control 3	4	25	6.25	33	8.25
Control 4	4	25	6.25	28	7.00
Control 5	4	23	5.75	28	7.00

As displayed in Table 1, the highest and second-highest posttest means were obtained by the groups receiving the learning style intervention, with 13.75 and 12.75, respectively. Both groups from Learning Style and Grading Scale followed, each obtaining 10.75. Next came the Grading Scale group with a mean of 9.75, followed by the Learning Style group with 8.25, which is also the highest posttest mean obtained by the Control group. The lowest mean, 6.50, was recorded in the Control group. Those in the Learning Style group achieved three of the top posttest means. The bottom three are from the control groups. These results agreed with Rosario and Bautista's (2021) study on the performance of senior high school students, which found that heterogeneous groups achieved higher total mean scores than homogeneous groups for both low- and high-ability learners. Among high-ability learners, those in heterogeneous groups performed significantly better than those in homogeneous groups. They recommended grouping learners heterogeneously to benefit both low- and high-ability learners. To account for heterogeneity within the experimental group in this study, students' names were stratified by learning style and grade-level descriptors. They are selected using the fishbowl technique to ensure a fair distribution of group

membership. Procedural knowledge and problem-solving were significantly higher in a heterogeneous group (Černilec *et al*., 2023b). According to Singh and Agrawal (2011b), group heterogeneity is an element of cooperative learning. They recommend that a group should be as small and heterogeneous as possible. Donovan *et al*. (2018) found that heterogeneous groups (thoughtfully formed by the instructor) produced better learning outcomes and more positive attitudes (satisfaction) toward group work. Jacobs *et al*. (2008) suggested that teachers should make conscious decisions about how students will work together as a group, rather than leaving this to chance or students' choice. This study indicates that systematic heterogeneous grouping based on VARK learning styles and learners' ability, as represented by their previous mathematics grades, yielded higher achievement than random grouping.

3.2 Consolidated Pretest and Posttest Results of All Groups

Table 2 presents the mean scores for the pretest and posttest across the three learner groups, categorized by grouping technique. For the pretest results, the Grading Scale group achieved a mean score of 6.2, the Learning Style group scored 6.15, and the Control group obtained 6.8. Students' learning style affects student achievement in Mathematics (Gusanttika *et al*., 2017). It showed that the pretest mean scores of the three groups are relatively close to each other, with differences of only 0.05 to 0.65. The posttest mean score revealed considerable differences. Learning Style groups had the highest mean score of 10.65, followed by the Grading Scale group with 8.75, and then the Control group with 7.35. These posttest differences range from 1.40 to 3.30. In their research, Sintia et al. (2019) found that learners in cooperative groups who were taught according to their learning styles achieved significantly better outcomes than those in groups where instruction did not match their learning styles. It can be observed that learning style played a critical role in the students' achievement in this study.

Table 2. *Summary Mean Scores for Pretest and Posttest of the Grouping Techniques Used*

		Pretest		Posttest	
Groups	**N**	**X**	**M**	**X**	**M**
Grading Scale	20	124	6.2	175	8.75
Learning Style	20	123	6.15	213	10.65
Control	20	136	6.8	147	7.35

Virgana (2019) concluded that learning style significantly influences mastery of mathematics. Sari *et al*. (2025) noted that learning style significantly affected the ability to communicate, construct mathematical models, represent concepts, and solve problems. There is a positive impact on the connection between the learning styles and mathematics achievement (Hariri *et al*., 2025). Villajuan (2019), in her study on the relationship between learning style and academic achievement of grade 8 mathematics learners, found that the learning style and academic achievement were significantly related. This research also aligns with Önder and Silay's (2015) study on the importance of learning styles in forming successful cooperative groups, which found that learners in cooperative groups based on learning style are more effective than those in cooperative groups based on academic success. The results of this study show that participants in the Learning Style groups outperformed those in the Grading Scale and Control groups.

3.3 The Differences in the Mean Scores of Experimental and Control Groups in Pretest and Post-test

Table 3 presents the differences in the mean pretest and posttest scores across the three learner groups, based on the grouping techniques used. This comparative result shows which group had the most significant increase in pretest-to-posttest differences. The Control Group exhibited the least pretest-posttest mean difference at 0.55. The Grading Scale group obtained a mean difference of 2.25. The Learning Style group with the most significant increase has a mean difference of 4.5. As observed, the learners with different learning styles in a group support and complement one another's strengths and weaknesses. It facilitates effective group adaptation and a deeper grasp of the lesson.

Table 3. *The Differences in Mean Scores of the Three Grouping Techniques Used, Showing Their Respective Achievements in Numeracy*

Groups	Pretest M	Posttest M	Mean Difference
Grading Scale	6.2	8.75	2.25
Learning Style	6.15	10.65	4.5
Control	6.8	7.35	0.55

According to Sriphai *et al*. (2011b), learning styles are endogenous variables that exhibit relatively consistent preferences for learning processes, regardless of the task or problem. Kyprianidou *et al*. (2012) claimed that

learning-style-based grouping improves teamwork because students share their skills according to their learning style, enabling them to learn from one another, consciously or unconsciously. The interaction of students with different learning styles helps each other develop their skills, which enhances their group achievement. Soetanto *et al*. (2017) observed that groups formed based on heterogeneous learning styles experienced fewer task-related problems. Oflaz and Turunc (2012) also observed that learners were willing to take each part of an activity, which helped them become easily motivated. Mayordomo (2014) found a significant relationship between cooperative learning and social skills, and that students' skills developed in heterogeneous grouping. Khamphaya *et al*. (2022a) found that heterogeneous teams (with mixed VARK learning preferences) outperformed both homogeneous teams (with the same VARK learning preferences) and individual learners on tests.

3.4 The Significance of Mean Gains in Numeracy Outcomes

Table 4 shows the analysis of the significance of the gain scores for both the experimental and control groups.

Table 4. *ANOVA Source Table of the Grouping Techniques Used and Achievements in Numeracy*

Source of Variation	SS	Df	Ms	F*	F-critical
Between	39.01	2	19.50	4.24	3.89
Within	55.23	12	4.60		
Total	**94.23**	**14**			

*p = 0.0405

The calculated $F(2, 12) = 4.24$, $p = 0.0405$, exceeds the tabulated value of 3.89 at (2, 12). It indicates that at least two of the means are significantly different. Since this difference is statistically significant, the null hypothesis is rejected. Therefore, this result revealed that the use of grouping techniques can significantly enhance numeracy outcomes, particularly when learning style is used as a basis for grouping learners. Consistent with the study of Khamphaya *et al*. (2022b), supporting the idea that grouping by diverse learning styles leads to higher academic achievement. This study highlights the importance of systematically grouping learners in mathematics classes, as it impacts both achievement and social dynamics among students.

4.0 Conclusion

The findings of this study revealed that the pretest mean scores of both the experimental and control groups showed minimal differences, suggesting a similar baseline performance across the groups. However, significant disparities emerged in the posttest results, with the Learning Style Group demonstrating the most significant mean gain among the three grouping techniques. These outcomes suggest that students in the Learning Style Group outperformed those in the Grading Scale and Control Groups. The posttest data further indicated that the mean scores of participants in the experimental groups were higher than those in the Control Group, resulting in higher mean gains for the experimental groups, particularly the Learning Style Group. In the analysis of variance, the results confirmed a statistically significant difference between the experimental and control groups, with learners in the Learning Style Group showing the most significant improvement, demonstrating the effectiveness of this grouping technique in enhancing numeracy outcomes.

This study highlights the importance of heterogeneous grouping in cooperative teaching strategies for numeracy achievement, utilizing a systematic approach that considers learners' diverse learning styles to create optimal learning groups that maximize achievement. It supports the findings of Sintia *et al*. (2019), who found a significant difference in achievement between learners in cooperative groups formed based on learning styles and those in groups where instruction did not align with their learning styles. Another, Villajuan (2019), in her study on the relationship between learning style and academic achievement of grade 8 mathematics learners, found that the learning style and academic achievement were significantly related and thus recommended that teachers should employ interventional activities according to the learning styles of students to make them motivated to learn as well as achieve high performance. Also, Igwe and Iweka (2019), in the implications of their study, mentioned that learners study better when their preferred learning style is known to improve their mathematics achievement, and concluded that learners with read/write and joint learning styles significantly predict their mathematics achievement. Moreover, Dakay *et al*. (2023) found a significant correlation between learners' preliminary performance and their learning styles. They recommended considering students' learning styles and developing an adaptive learning plan to improve students' performance. Equally, Cercado (2023) concluded that there is a significant relationship between learners' academic performance in mathematics and their visual and kinesthetic learning styles. They recommend that learners know their learning styles to develop their mathematics performance. Lastly, Ocampo *et al*. (2023) emphasized that recognizing and accommodating students' learning

styles is important. They found that visual, auditory, and kinesthetic learning styles benefit significantly when the teaching method aligns with them and suggested that this should be the basis for teachers to tailor instructional design to improve academic performance.

In a cooperative teaching strategy, grouping learners is a crucial task among teachers that requires extensive effort and planning to achieve the greatest possible benefit. Once learners are organized into heterogeneous groups, their groups can accommodate a variety of instructional activities and challenges, leading to higher performance. Beronilla and Natividad (2025) recommended considering learning styles when forming heterogeneous groups. Noting that it will enhance members' achievement and that, within cooperative learning frameworks, it offers a multifaceted approach to advancing educational outcomes.

To further assess the impact of learning-style-based heterogeneous grouping, the researchers recommend applying the same scheme in other learning areas, such as History/Social Studies, English Language Arts, and Science, given their frequent use of grouping strategies in lesson delivery. In the same manner, considering other learning style theories like, Hill (1976) Cognitive Style Interest Inventory, Kolb (1984) Experiential Learning, Felder and Silverman (1988) Felder-Silverman Learning Style Model, Entwistle and Tait (1995) Surface-deep, and Briggs et al. (2001) SPQ, or conducting in different locales particularly in larger schools where the population is highly diverse.

5.0 Contributions of Authors

Author 1: conceptualization, proposal writing, data gathering, data analysis
Author 2: research adviser

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7.0 Conflict of Interests

The authors declare no conflict of interest.

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