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Utilizing Salazar's Grouping Method in Improving Learners' Performance on the Applications of Right Triangle

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ABSTRACT

This quantitative study aimed to utilize Salazar's Grouping Method in improving grade 9 learners' performance on the applications of right triangle. The researcher adapted and validated a solving real- life problems from a variety of sources that was originally created using a two-way Table of Specification (TOS) that was aligned with the DepEd-MELC Curriculum. Ninety- six (96) learners from one of the branches of Mindanao State University External Units in Lanao del Sur, Philippines, forty- eight (48) learners were assigned to control group and forty- eight (48) in experimental group who took part in the study in two- weeks intervention. Learners' performance refers to the problem- solving test that was rated with validated rubric. Problem- solving test was used which consisted of five problem-solving problems. The hypothesis was evaluated at the 0.05 level of significance, and the data were analyzed using Mann- Whitney U Test, Wilcoxon Signed Rank, and Intraclass Coefficients. The findings of the study revealed both groups made improvements however the experimental group showed significant differences in the posttest results with mean of 17.57 (SD = 4.64) categorized as Very Satisfactory Improvement and higher than the control group's mean of 12.92 (SD = 4.86) categorized as Satisfactory Improvement. This implies that utilizing Salazar's Grouping Method was effective to improve learners' performance particularly on the applications of right triangle. Learners' performance was found improved from no improvement to very satisfactory with e mean gained score of 14.65. Based on the results, learners require additional exposure, practice and collaborative activity that will boost their confidence, communication skills such as the Salazar's Grouping Method in order to fully learn the applications of right triangle and apply them to problem solving. Thus, integrating interview, student reflections will help to further explore performance and understand deeper the effects of the Salazar's Grouping Method.

Key Words: Applications of Right Triangle, Grade 9 Mathematics, Learners' Performance. Problem- Solving Test, Salazar's Grouping Method.

1. INTRODUCTION

Cooperative learning is cognitive theories emphasize the advantages of teamwork more than its motivational theories, which emphasize students' incentives to finish assignments. International studies have shown that collaborative learning can positively impact academic achievement and attitudes towards mathematics (OECD, 2016). This global perspective underscores the relevance of the study's findings beyond the context of Pakistan. This theoretical framework suggests that collaborative learning can facilitate the mathematics education among students in terms of their math achievement and attitude towards mathematics (Schreiber & Valle, 2013). Thus, Salazar's Grouping Method is a distinctive small grouping cooperative learning strategy that uniquely combines individual accountability with dynamic group formation. Unlike traditional methods such as Jigsaw, Think-Pair-Share, Students Teams- Achievement Divisions were mainly focus on fixed group structures (Salazar, 2014).

However, According to Maknun et. al (2022), there are a number of epistemological challenges that students encounter when learning trigonometry. These challenges include the inability to comprehend the connection between trigonometric ratios and angles, the challenge of using trigonometric ratios in real-world scenarios, the inability to distinguish between various trigonometric functions and their characteristics, and more. According to his article,

resolving these issues is crucial to enhancing mathematics education generally. Thus, this study aims to utilize Salazar's Grouping Method in improving grade 9 learners' performance on the applications of right triangle that extends the scope to improve the learners' performance as a key component thereby contributing an innovative perspective to the field and going beyond just transferring knowledge.

2. OBJECTIVES

The primary focus of this study lied in utilizing Salazar's Grouping Method in improving grade 9 learners' performance on the applications of right triangle. Specifically, this study aimed to:

1. Assess the learners' performance on the applications of right triangle.
2. Investigate the mean score of learners' pretest and post test scores both experimental and control group.

3. METHODOLOGY

The study used quantitative research design. Since the competency itself will take one to two weeks, they were split into two groups: Group 1 for experimental group, who received the intervention Salazar's Grouping Method; and Group 2 for the control group, who took traditional teacher-based classes. For quantitative data collection, the researcher was initially administered a validated Problem-Solving Test (PST), a pre- test to all groups to examine their performance specifically in problem solving prior to the intervention, which will serve as a baseline.

After the intervention, learners from all groups will be administered a parallel validated Problem-Solving Test (PST), a post-test to examine the progress of their performance on the applications of right triangle specifically uses of trigonometric ratios in solving real life problems involving right triangle. Their scores were analyzed using Descriptive statistics, Mann- Whitney U Test, and Wilcoxon Signed Rank to compare the significant differences between the control and experimental groups of the learners.

For qualitative data, fifteen (15) selected learners from experimental group conducted an additional interview to gather more in-depth data. They were selected based on various factors, such as participation and performance. The collected data were analyzed through thematic analysis, a pattern or recurring ideas that relate to the learners' experiences and perceptions.

4. DATA ANALYSIS

This chapter presents the findings and interpretations of the data analysis for both quantitative and qualitative data. The presentation follows the objectives. To display the study's results, tabular figures and textual formats were employed.

4.1 Quantitative Data Analysis

The discussion below presents the results of the quantitative data analysis and interpretation on the performance of the learners in the problem-solving test. It defines the utilization of Salazar's Grouping Method and Traditional Teaching Method (Teacher Based) in teaching the applications of right triangle.

4.1.1 Learners' Performance on the Application of Right Triangle

To assess the learners' performance on the application of right triangle, a problem-solving test was administered to them. This test was composed of five questions with a space provided for the solutions. It covered one of the competencies in DepEd Curriculum, specifically the uses of six trigonometric ratios in solving real life problems involving right triangle.

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Table 1. Gain Scores Descriptions

Raw Scores	Performance Improvement Descriptions	Code
20- 25	Outstanding Improvement	OI
15- 19	Very Satisfactory Improvement	VS
10- 14	Satisfactory Improvement	SA
5 - 9	Slight Improvement	SL
Below 5	No Improvement	NI

Table 1 presented the Raw scores of the learners in the test. Raw scores were made based on the highest and lowest possible scores gained by the learners Each item on the test was scored using a validated scoring rubric, gaining up to five points and for a total of 25 points. This classification makes it possible to interpret the learners' performance gain after the intervention in a more relevant way.

Learners with a gained score of below five were categorized as No Improvement (NI), which indicates a lack of observable improvement or the subject is difficult to learn and that extra teaching support is required. Scores for Slight Improvement (SI) range from 5 to 9, signifying they slightly improved their performance. Though they may not yet have a strong understanding, some learners may have begun to understand topics. In addition, gained scores ranging from 10 to 14 are categorized as Satisfactory Improvement (SA), which means that learners made an outstanding improvement on the application of right triangles.

Similarly, learners with scores in the 15–19 range demonstrated Very Satisfactory Improvement (VS). These students advanced significantly and most likely benefited from the teaching approach, particularly Salazar's Grouping Method. Finally, the Outstanding Improvement (OI) category was assigned to individuals who achieved a gain score of 20 to 25. This suggests learners had an outstanding performance improvement, demonstrating an outstanding understanding of the subject matter and even the ability to solve right triangle problems.

Table 2. Frequency and Percentage of Learners' Scores in Problem- Solving Test (Pretest)

Scores	Control Group				Experimental Group			
	f	%	Mean	SD	f	%	Mean	SD
1	3	6.25	**2.50**	**0.72**	3	6.25	**2.79**	**0.92**
2	21	43.75			10	20.83		
3	21	43.75			23	47.92		
4	3	6.25			12	25.0		
TOTAL	**48**	**100**			**48**	**100**		

Table 2 shows the pretest results for the problem-solving test for learners in the experimental and control groups. The test's twenty-five (25) total items revealed learners in both groups only scored between one and four. The majority of learners in the experimental group, 23 or 47.92%, lay under the total score of 3, whereas 42 out of 48

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learners in the control group, or 87.5%, lay under the total score of 2 or 3. Some members in both groups, however, also received a total score of 4, with the experimental group receiving 12 points or 25%, and the control group receiving 3 points or 6.25%.

Table 3. Frequency and Percentage of Learners' Scores in Problem-Solving Test (Posttest)

Scores	Control Group				Experimental Group			
	f	%	Mean	SD	f	%	Mean	SD
3	1	2.08						
5	2	4.17						
6	3	6.25						
7	1	2.08						
8	4	8.33			4	8.33		
9	3	6.25						
10	3	6.25						
11	2	4.17			1	2.08		
12	5	10.42			3	6.25		
13	1	2.08	**12.92**	**4.86**	1	2.08	**17.56**	**4.64**
14	2	4.17			1	2.08		
15	2	4.17			2	4.17		
16	5	10.42			7	14.58		
17	4	8.33			2	4.17		
18	3	6.25			5	10.42		
19	3	6.25			8	16.66		
20	3	6.25			2	4.17		
21	1	2.08			2	4.17		

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22					3	6.25		
23					2	4.17		
25					5	10.42		
TOTAL	**48**	**100**			**48**	**100**		

The experimental and control group learners' posttest results were shown in Table 8. According to the findings, 10.42% of the learners in the experimental group achieved a perfect score, while 72.92%, or the majority, obtained more than half of the possible points. Conversely, half of the learners in the control group achieved a score higher than half of the perfect score, and half received a score lower than average. Yet, the experimental group's average score was 17.56, and the control group has 12.92. It is also evident that a small percentage of learners gained 8 as the lowest score in the experimental group, and the control group is 3 on the test.

Therefore, even though the mean score for the two groups differed by 4.64, it is evident that the score distribution was not similar. This implies that learners in both groups performed better on the problem-solving test. Since the majority of the experimental group gained excellent test scores, it is clear that they improved more. Therefore, using Salazar's Grouping Method will help learners perform better especially when it comes to the applications of right triangle. Additionally, this suggests that using Salazar's grouping method for the control group will also aid in improving their performance.

Table 4. Frequency, Percentage, and Interpretation of Learners' Scores (Both Groups)

Raw Scores	PRETEST						POST TEST					
	Control Group			Experimental Group			Control Group			Experimental Group		
	f	%	IP	f	%	IP	f	%	IP	f	%	IP
20- 25							4	8.33	OI	14	29.17	OI
15 - 19							17	35.42	VS	24	50	VS
10 - 14							13	27.08	SA	6	12.5	SA
5 - 9							13	27.08	SL	4	8.33	SL
Below 5	48	100	NI	48	100	NI	1	2.08	NI			
Total (Mean)	48	100	**0.04**	48	100	**0.04**	48	100	**2.62**	48	100	**3.43**
Level of Improvement			**NI**			**NI**			**SA**			**VS**

Legend: IP- Interpretation: **OI-**Outstanding Improvement: **VS-** Very Satisfactory Improvement: **SA-** Satisfactory Improvement: **SL-** Slight Improvement: **NI-** No Improvement

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Scaling:

4.01 – 5.00 – *OI* 2.01- 3.00 – *SA* 0.00- 1.00 - *NI*
3.01- 4.00 -*VS* 1.01- 2.00 - *SL*

Group	Test	Comparison of Raters	ICC (3,1)	Interpretation *(Koo and Li, 2016)*
Control	Pretest	Rater 1 vs. Rater 2	1.000	Excellent
	Posttest	Rater 1 vs. Rater 2	0.989	Excellent
Experimental	Pretest	Rater 2 vs. Rater 1	0.916	Excellent
	Posttest	Rater 2 vs. Rater 1	0.983	Excellent

Table 4 shows the frequency, percentage, and interpretation of the learners' results in the control and experimental groups throughout the pretest and posttest. All of the 48 learners in the experimental and control groups obtained a score below 5 on the pretest, categorizing them in No Improvement category. This finding suggests that learners had a lack of understanding before the intervention and were unable to provide complete answers that met the rubric's requirements. There was a change in performance following the intervention. Only one learner remained in the NI category on the posttest for the control group; the other learners were split among the following higher categories: 13 in SL (27.08%), 13 in SA (27.08%), 17 in VS (35.42%), and 4 in OI (8.33%). As a result, this group's mean interpretation changed from no improvement to satisfactory. This suggests slight improvements on the problem-solving exam.

Comparatively, the experimental group's posttest scores improved more when they were instructed utilizing Salazar's Grouping Method. None were still classified as NI. Rather, there were four students in SL (8.33%), six in SA (12.5%), twenty-four in VS (50%), and fourteen in OI (29.17%). Similarly, this group's mean interpretation increased from No Improvement to Very Satisfactory, indicating an improved level of performance in solving problems on the applications of right triangles. Thus, even though both groups made improvement the experimental group showed greater increases in the frequency of higher scores and performance level.

4.1.2. *Learners' Mean Score in Pretest and Posttest Scores*

To investigate the mean score of learners' performance in pretest and posttest scores for both the experimental and control groups, a Mann-Whitney U test and Wilcoxon signed-rank test were applied since the results of the learners' pretest and posttest scores for both groups were not normally distributed. The pretest was administered prior to the implementation of the intervention to assess the learners' initial understanding in relation to the applications of right triangles. The results were used as a baseline for their performance. After the intervention, which utilized Salazar's Grouping Method in the experimental group, a posttest was administered also to both groups to measure any improvement in their performance.

Table 5. Intraclass Correlation Coefficient Test Results

Score	DepEd Grading System		Levels of Improvement
	Grade Ratings	Interpretations	
20 - 25	90- 100	Outstanding	Outstanding Improvement
15 - 19	85- 89	Strongly Satisfactory	Very Satisfactory Improvement
10 - 14	80-84	Satisfactory	Satisfactory Improvement

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5 – 9	75-79	Fairly Satisfactory	Slight Improvement
Below 5	Below 75	Did Not Meet Expectations (Failed)	No Improvement

***ICC (3,1) = two- way mixed effects model, single measures, consistency type*

Table 5 indicated the objectivity and consistency of scoring; inter-rater reliability between Rater 1 and Rater 2 was computed using a two-way mixed effects model, single measures, and consistency type for both the control and experimental groups. The control group showed excellent intraclass correlations with coefficients of 1.000 for the pretest and 0.989 for the posttest. Similarly, the experimental group showed excellent correlations with a 0.916 correlation in the pretest and 0.98 for the posttest. Thus, there is a significant positive correlation between the ratings given by the two teachers in the pretest and posttest of the problem-solving test. This implies that the two raters are consistent in rating the problem-solving test.

Table 6. Score-Based Classification of Learners' Performance using DepEd Grading System and Improvement Levels

Score	DepEd Grading System		Levels of Improvement
	Grade Ratings	**Interpretations**	
20 - 25	90- 100	Outstanding	Outstanding Improvement
15 - 19	85- 89	Strongly Satisfactory	Very Satisfactory Improvement
10 - 14	80-84	Satisfactory	Satisfactory Improvement
5 – 9	75-79	Fairly Satisfactory	Slight Improvement
Below 5	Below 75	Did Not Meet Expectations (Failed)	No Improvement

**DepEd Grading System (DepEd Order No. 8, s.2015)*

Table 6 illustrated the score descriptions on the problem-solving test that the learners gained. The researcher aligned the learners' performance on the problem-solving test with the DepEd grading system to interpret the results accurately. A 5-point rubric was used to score each item on the problem-solving test, which consists of five real-world problems pertaining to the applications of right triangles. Learners are assessed on their ability to recognize the given and unknown, provide the correct formula and solution, and provide an accurate final answer with justification. According to DepEd Order No. 8, s., the DepEd Grading System. Grades range from 74 and lower (Did Not Meet Expectations) to 90–100 (Outstanding) in 2015. These ratings were compared to improvement thresholds determined by the researcher in order to better represent learner development rather than merely end-point performance.

For learners who scored between 0 and 4, DepEd labeled their grades as "Did Not Meet Expectations" since the scores were 74 and below. No Improvement (NI) was the classification given to these learners based on the problem-solving test, Slight Improvement (SI), equivalent to Fairly Satisfactory (75–79), was defined as a score of 5 to 9. Likewise, learners who scored between 10 and 14 were classified as Satisfactory Improvement (SA) and given the Satisfactory grade (80–84). Those with scores between 15 and 19 were seen as showing very satisfactory improvement (VS), while those with scores between 85 and 89 were considered strongly satisfactory. Lastly, scores in the Outstanding (90–100) range, which fall between 20 and 25, were identified as demonstrating Outstanding Improvement (OI). The researcher's improvement levels serve to illustrate the extent of academic success made as a result of the intervention, even though the DepEd system represents mastery on a nationwide level. It is essential for determining how far learners have improved from their baseline (pretest) performance as well as where they ended up following the posttest.

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Table 7. Comparisons of Pretest and Posttest Within Groups

Groups and Test Compared		N	Median	Sum of Ranks	Test Used	Test Statistic	W-critical value	Interpretation
Within Groups	Pretest vs. Posttest (Control)	48	10.50	W=1176	Wilcoxon Signed Rank	0.00	396	*Significant*
	Pretest vs. Posttest (Experimental)	48	15	W=1176		0.00	396	*Significant*

**Significant at the 0.05 level*

Table 7 showed the results of the Wilcoxon Signed Rank test for both the experimental and control groups. This demonstrated that both groups' posttest scores improved statistically significantly in comparison to their pretest results. The traditional teacher-based approach was used to teach the control group. The median score for 48 learners was 10.50 between the pretest and posttest, with a test statistic of 0.0 and is quite far or of less than the 0.05. The test showed that the improvement was statistically significant. Hence, learners' performance was significantly impacted by Salazar's Grouping Method especially in the experimental group with a median score of 15 between pretest and the posttest indicating a very satisfactory improvement.

The findings demonstrate that when comparing group-based learning to traditional teacher-led instruction, Slavin (2014) discovered that learners in organized groups outperformed the others in answering mathematical problems.

Table 8. Comparisons of Pretest and Posttest Between Groups

Groups and Test Compared		N	Mean	Mean Rank	Sum of Ranks	U	Test Used	$p-$ values	Interpretation
Between Groups	Pretest **(Control)** vs. Pretest **(Experimental)**	48	2.50	43.50	2088	912	Mann-Whitney U Test	0.608	*Not Significant*
			2.79	53.50	2568.				
	Posttest **(Control)** vs. Posttest **(Experimental)**	48	12.92	36.65	1759.	583		$p <$ 0.001	*Significant*
			17.56	60.35	2897.				

**Significant at 0.05 level*

Table 8 showed the results of the Mann-Whitney U test comparing the experimental and control groups before and after the intervention. The experimental group mean score was 2.79 somewhat higher on the pretest than the control group with the mean 2.50, and based on the U value of 912 with *z*- value of 0.392 and $p-$value of 0.608, indicating that the difference was not statistically significant. This result guarantees a fair assessment of the interventions' effects by confirming that the two groups were statistically equal at baseline.

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In contrast, the experimental and control group showed significant differences in the posttest results. The experimental group's mean was 17.56, higher than the control group's mean of 12.92, also a *p*-value of less than 0.001, and a U value of 583 with *z*- value of -4.17, showing that it is failed to reject the null hypothesis and indicates there is a significant difference between the two groups and that improvement in the experimental group was both practically and statistically significant. According to Hernández-Sellés et al. (2019), there is a substantial correlation between student interactions in workgroups and collaborative learning.

Table 9. Frequency, Percentage and Interpretation of Gain Scores

Gain Scores Range	Control Group			Experimental Group		
	f	%	IP	f	%	IP
22- 25				3	6.25	OI
17- 21	5	10.42	VS	13	27.08	VS
12 – 16	17	35.42	SA	23	47.92	SA
7 – 11	15	31.25	SL	5	10.42	SL
2 – 6	11	22.92	NI	2	4.16	NI
Total (Mean)	48	100	2.13	48	100	2.92
Level of Improvement			SA			SA

Legend: IP- *Interpretation:* ***OI-****Outstanding Improvement:* ***VS-*** *Very Satisfactory Improvement:* ***SA-*** *Satisfactory Improvement:* ***SL-*** *Slight Improvement:* ***NI-*** *No Improvement*

Scaling:

4.01 – 5.00 – *OI* 2.01- 3.00 – *SA* 0.00- 1.00 - *NI*
3.01- 4.00 -*VS* 1.01- 2.00 - *SL*

Table 9 illustrated the frequency, percentage and interpretation of gained scores after the intervention for both experimental and control groups. Clearly, both groups gained scores range 2- 6 which was classified as No Improvement (NI). However, majority or 35.42% and 47.92% gained scores range of 12- 16 from control and experimental group, respectively indicating that most learners satisfactorily improved. The experimental group was improved more as there is 27.08% gained 17- 21 scores range and 6.25% in 22- 25 scores range. Above all, both groups had a mean gained scores of 2.13 and 2.92 for control and experimental group, respectively showing that they were satisfactorily improved and is meaningful. Thus, cooperative learning techniques improve students' outcomes and perspectives on mathematics (Zakaria et al., 2013).

Table 10. Comparisons of Gained Scores Between Groups

Groups and Test Compared	N	Mean	Mean Rank	Sum of Ranks	U	Test Used	*p* – values	Interpretation
Gained Scores (**Control)** vs.	48	10.42	37.53	1801.5	625.5	Mann-Whitney U Test	$p < 0.001$	*Significant*
(Experimental)		14.67	59.47	2854.5				

**Significant at 0.05 level*

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Table 10 presented the Mann-Whitney U test results of gained scores between the control and experimental groups after the intervention. The experimental group with 48 learners attained a higher mean gain of 14.64 and classified as "Very Satisfactory" (VS) whereas the control group with 48 learners achieved a mean gain of 10.42 falling below the "Satisfactory" (SA) level of improvement. Both groups showed improvement, the U value is 625.50, with a p-value of less than .001, demonstrating that there is statistically significant difference between the mean gained scores before and after the intervention. These results imply to that there is a significant improvement on the mean scores on the problem-solving test before and after the implementation in both experimental and control groups.

5. RESULTS AND DISCUSSION

This study was found out that even though the experimental groups' scores were higher than those of the control group, learners in both groups nevertheless rated their performance on the pretest problem-solving test as bad. The majority of learners did, in fact, only write the provided information, while some either left the space blank or simply entered the numbers without indicating what they corresponded.

According to Maknun et al. Al (2022) states that when learning trigonometry, learners face a variety of epistemic difficulties. These difficulties include the inability to understand how trigonometric ratios and angles are related, the difficulty of applying trigonometric ratios in practical situations, the incapacity to differentiate between different trigonometric functions and their properties, and more. This implies that improving mathematics education in general depends on fixing these problems.

Furthermore, although the traditional teaching approach (teacher-based) yields a positive impact on learners' performance, the experimental group's utilization of Salazar's Grouping Method resulted in higher learning improvements which implies that collaborative teaching methods are more successful in improving learners' performance, particularly in solving real-world problems with right triangles. This suggests that collaborative, well-designed educational interventions can raise learners' academic performance and push them beyond, resulting in a greater knowledge of mathematics.

Gilles (2016) investigated how collaborative learning techniques affected the instruction of right triangle applications in a classroom setting. According to the findings, students' capacity to apply principles to real-world problems and overcome trigonometry misconceptions was enhanced by organized group discussions. Similarly, students who participated in peer discussions while working on problem-solving activities showed a stronger knowledge of concepts, according to Mercer and Howe (2012).

Both groups showed significant performance improvements; however, the experimental group outperformed the control group in terms of posttest mean. This implies that the experimental group utilizing Salazar's Grouping Method was more effective than traditional instruction in improving learners' performance on right triangle applications in real-world situations. The findings demonstrate that cooperative and collaborative learning can improve learners' performance, and even though both teaching strategies produced significant improvements, the experimental group's highly positive performance suggests that structured collaboration and interactive problem-solving exercises are beneficial additions to mathematics education.

Hence, Johnson et al. (2014), students frequently feel a greater sense of success when they work together to solve difficult challenges. Interactivity improves collaborative learning, which in turn raises student performance, claim Chand et al. (2019). Interactivity also promotes active participation, according to Shapiro et al. (2017). Engaging with peers encourages students to exchange ideas and knowledge. These findings illustrate the intervention's effective and imply that utilizing Salazar's Grouping Method will improve learners' ability to solve real-world right triangle problems.

6. CONCLUSIONS

This study drawn was aimed to utilize Salazar's Grouping Method in improving grade 9 learners' performance on the applications of right triangle. After a systematic analysis, some insights and realizations were drawn. Although the traditional teaching approach (teacher-based) yields a positive impact on learners' performance, the experimental group's utilization of Salazar's Grouping Method resulted in higher learning improvements which

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implies that collaborative teaching methods are more successful in improving learners' performance, particularly in solving real-world problems with right triangles. This suggests that collaborative, well-designed educational interventions can raise learners' academic performance and push them beyond, resulting in a greater knowledge of mathematics. This also proven that utilizing Salazar's Grouping Method will greatly help learners to improve in particular to solving real life problems involving right triangle.

7. RECOMMENDATIONS

Based on the results, there are some key important implications need to attain for deeper understanding and best result. These include the conducting of interview, self-reflections and the extension of the implementation beyond two weeks, and having a two or three experimental group to have greater impact and best results.

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