

LEARNING STYLES AND MATHEMATICS PERFORMANCE OF GRADE 11 STUDENTS AT THE UNIVERSITY OF BOHOL

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ABSTRACT

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This study determined the influence of learning-style-based instruction on the mathematics performance of Grade 11 students at the University of Bohol during the first semester of School Year 2022-2023. A quasi-experimental pretest-posttest control group design with 155 students enrolled in General Mathematics was used. The Honey and Mumford Learning Style Inventory was used to determine students' preferred learning styles; researcher-developed pretest and posttest measures were used to assess mathematical performance. Data were analyzed using mean, standard deviation, paired-samples t-test, independent samples t-test, and one-way analysis of variance. Results showed that both control and experimental groups' mathematics performance improved significantly following the intervention ($p < .001$). However, the posttest scores and mean gains did not differ significantly between the two groups. In addition, no significant difference in posttest scores was found by learning style preference ($F = 0.587, p = .765$). The study revealed that learning styles have no significant effect on students' achievement in mathematics. This may suggest that classroom environment,



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learner involvement, and quality instruction are more beneficial for increasing mathematics performance than learning styles.

INTRODUCTION

Mathematics is an essential part of education and life. It influences problem-solving, decision-making, financial literacy, and logical thinking. It is also seen as a key driver of economic and technical progress, especially in developing nations, where mathematical skills contribute to national productivity and innovation (Bosman & Schulze, 2018). However, many students develop unfavorable attitudes towards mathematics, which result in anxiety, indifference, and poor academic achievement (Adu & Duku, 2021). Student achievement in mathematics remains a primary concern of educators. Another factor related to academic achievement is the compatibility between teaching methods and students' preferred learning styles. Traditional classroom instruction generally emphasizes teacher-centered methods that may not accommodate the different ways pupils process and understand information. Thus, mismatches between teaching styles and learning preferences may decrease student engagement and accomplishment (Chetty et al., 2019).

Learning styles are the ways people learn, process, and recall information. Understanding these preferences may enable teachers to develop more responsive teaching strategies to promote classroom engagement and academic achievement. Although some research indicates that teaching to preferences can boost motivation and learning results, the findings are mixed across settings and disciplines (Yilmaz et al., 2016).

Much research has examined learning styles and academic achievement, but findings are inconsistent on whether a learning style improves mathematics achievement. Furthermore, few studies have investigated learning style-based instruction among Senior High School students in local Philippine settings, particularly in Bohol. These inconsistencies highlight the need to examine the extent to which the match between instruction and students' learning styles is a critical factor in mathematics achievement in the context of General Mathematics.

Mathematics is one of the major subjects in the Senior High School curriculum of the University of Bohol. Aligned with the institution's commitment to scholarship, character, and service, this study sought to determine the effect of learning styles on the mathematics performance of Grade 11 students during the first semester of School Year 2022–2023.

Theoretical Background. This work was grounded in David A. Kolb's Experiential Learning Theory, which holds that learning occurs through the transformation of experience (Kolb, 1984). According to Kolb, people acquire preferred learning methods based on how they perceive and process information. The approach stresses that good learning is a process of concrete experience, reflective observation, abstract conceptualization, and active

experimentation. Based on these dimensions, Kolb has identified different learning styles that influence the way people approach learning tasks and problem-solving.

This theory underscores the need to identify students' different learning styles and to adapt teaching methods to the diverse needs of learners in mathematics education. Students may learn mathematical concepts more effectively if teaching strategies are matched to how they prefer to learn. They like to learn by reflecting, speculating, experimenting, or engaging in activities. Thus, Kolb's theory served as the conceptual basis for determining whether learning-style-based instruction is linked to the mathematical performance of Grade 11 pupils.

Review of Related Literature and Studies. Extensive educational research has examined the potential influence of learning styles on academic attainment. Dunn and Dunn (1993) define learning styles as how individuals focus, process, and retain information. Because learners differ in their understanding of concepts, instructional strategies should account for these differences to improve learning outcomes. Several studies have examined the correlation between learning styles and performance in mathematics. Bosman and Schulze (2018) found that learners' chosen learning styles were related to the mathematics achievement of secondary school learners in South Africa. Likewise, Chetty et al. (2019) showed that the way teachers teach significantly affects students' academic achievement, underscoring the need to align teaching styles with students' learning styles.

According to Adu and Duku (2021), teachers must be aware of the varying learning styles of their learners in order to select appropriate instructional resources and teaching methods for teaching mathematics. Similarly, Al-Balhan (2007) found that students taught in accordance with their learning styles performed better academically than those taught using standard methods.

Some research, however, found opposite results. Yilmaz et al. (2016) found no significant relationship between learning styles and mathematics achievement among eighth-grade students. Moreover, Kohan et al. (2021) found no significant difference between learning styles and the academic performance of nursing students in virtual learning environments. The inconsistent findings imply that the effect of learning styles on academic achievement remains ambiguous and may depend on the environment, subject area, and instructional methodologies.

The outcomes are diverse, but the literature has repeatedly indicated the necessity for responsive teaching approaches and learner-centered instruction to improve students' engagement and performance in mathematics.

RESEARCH METHODOLOGY

Research Design. This study employed a quantitative quasi-experimental research design using a pretest–posttest control group approach to determine the effect of utilizing learning styles on the mathematics performance of Grade 11 students at the University of Bohol. The control group received conventional instruction, while the experimental group was taught using strategies aligned with students’ identified learning styles. Topics covered included simple and compound interest, annuities, and propositional logic. Mathematics performance served as the dependent variable, while learning styles served as the independent variable.

Research Environment and Participants. The study was conducted at the Senior High School Department of the University of Bohol in the first semester of the School Year 2022–2023. The participants were 155 Grade 11 students enrolled in General Mathematics. Universal sampling was used in the study, and all students of the four sections were included. The experimental group consisted of students from STEM 2 and GAS CRIMPEDIA ($n = 78$), and the control group consisted of students from STEM 1 and GAS HW ($n = 77$).

Research Instruments. The study used the Honey and Mumford Learning Style Inventory, which is adapted from David Kolb’s Experiential Learning Theory (Kolb, 1984), to identify students’ preferred learning styles: activist, reflector, theorist, and pragmatist. The instrument contained 40 items with a four-point Likert scale.

Mathematical performance was assessed using researcher-developed pretest and posttest assessments with 80 multiple-choice items covering the defined General Mathematics abilities. The instruments were content-validated and pilot-tested prior to administration. “Cronbach’s alpha was used to determine internal consistency and scale reliability (Tavakol & Dennick, 2011).

RESULTS AND DISCUSSION

The pretest results showed that the control and experimental groups performed well in Mathematics before the intervention. Most students in both groups scored in the satisfactory range. This means that the students in both groups have the same basic knowledge and capabilities in General Mathematics. Some students had very satisfactory outcomes. In neither group did any student achieve an excellent grade on the pretest. In the control group, just one kid fell in the category of “did not meet expectations.” The mean scores of the two groups were very close, suggesting that the participants had nearly the same level of understanding of mathematics prior to the implementation of the teaching methods.

The results indicate that the pupils had prior foundational knowledge

in Mathematics before the intervention. The preponderance of scores at the satisfactory and moderately satisfactory levels underscores the need for instructional measures to improve students' mathematical comprehension and performance further.

The posttest findings following the instructional intervention showed considerable improvement in mathematics performance for both the control and experimental groups. Most children in both groups achieved very satisfactory performance. A good number of the pupils also achieved the excellent level. In addition, no student in either cohort had findings coded as "did not meet expectations." Average scores for both groups increased significantly from pretest values, demonstrating positive learning gains following the teaching time.

The gains for both groups show that the teaching practices used in the study had a beneficial impact on students' learning and achievement in arithmetic. This study suggests that both instructional approaches were associated with improved mathematics performance. The results of the present study corroborate Chetty et al.'s (2019) emphasis on the effects of instructional styles on students' academic progress and engagement. Flexible teaching strategies and consideration of students' preferences can boost math performance and classroom engagement (Adu & Duku, 2021). The fact that both groups increased equally suggests that learning styles may not be sufficient to explain children's success in mathematics. There are several other factors, such as motivation, classroom atmosphere, and quality of instruction, that may affect academic performance. The results indicated that the mathematics performance of both the control and experimental groups improved significantly from the pretest to the posttest. The mean scores of both groups were satisfactory at baseline, indicating baseline competence in General Mathematics. The control group had an average pretest score of 35.66, while the experimental group had a slightly higher average of 36.18. The results reveal no significant differences between the two groups of participants in their level of mathematical understanding before the application of the instructional strategies. Both groups performed well on the posttest following the instructional phase, with good means. The control group had an average score of 57.57, and the experimental group 56.01. The increase in scores from pretest to posttest indicates that both groups learned regardless of the instruction approach.

The control group showed a higher mean gain ($M = 21.91$) than the experimental group ($M = 19.83$). Both groups showed significant learning gains, but the modest difference in their scores suggests that both learning-style-based training and traditional teaching were effective in improving math competency. The results indicate that although learning styles may boost student engagement in the classroom, they do not necessarily lead to significantly better math performance than traditional teaching techniques. The findings are consistent with the findings of Yilmaz et al. (2016) and Kohan

et al. (2021), who found that learning styles do not have a significant impact on students' academic performance. This means that the quality of instruction, students' motivation, teachers' proficiency, and classroom interaction could play an important role in boosting mathematics achievement.

Table 1. Mean Difference Between the Pretest and Posttest Scores of the Control and Experimental Groups $N = 155$

Group	Test	Range	Minimum	Maximum	Mean	SD	Descriptive Level
Control Group (n = 77)	Pretest	43	15	58	35.66	8.60	Satisfactory
	Posttest	45	31	76	57.57	12.62	Very Satisfactory
	Mean Gain	49	-4	45	21.91	9.69	—
Experimental Group (n = 78)	Pretest	36	20	56	36.18	7.62	Satisfactory
	Posttest	49	28	77	56.01	11.38	Very Satisfactory
	Mean Gain	44	-3	41	19.83	9.89	—

Table 1 presents the mean differences between the pretest and posttest scores of the control and experimental groups. Prior to the intervention, both groups obtained satisfactory mean scores, indicating comparable baseline knowledge in Mathematics. The control group recorded a mean pretest score of 35.66 (SD = 8.60), while the experimental group obtained a slightly higher mean score of 36.18 (SD = 7.62).

Following the instructional intervention, both groups demonstrated substantial improvement on the posttest, achieving very satisfactory mean scores. The control group attained a mean posttest score of 57.57 (SD = 12.62), whereas the experimental group obtained a mean score of 56.01 (SD = 11.38). These findings indicate that learning occurred in both groups regardless of the instructional approach used.

In terms of mean gain scores, the control group showed a slightly greater improvement (M = 21.91, SD = 9.69) than the experimental group (M = 19.83, SD = 9.89). However, the difference between the groups was minimal, suggesting that both conventional teaching and learning style-based instruction contributed positively to students' mathematics performance.

The findings imply that while integrating learning styles may enhance classroom engagement and responsiveness, it did not result in markedly higher mathematics achievement compared with the conventional teaching approach. This supports the findings of Yilmaz et al. (2016) and Kohan et al. (2021), which reported that learning styles alone may not significantly influence students' academic performance, as achievement may also depend on instructional quality, student motivation, and classroom interaction.

Table 2. *Differences Between the Pretest and Posttest Scores of the Control and Experimental Groups N = 155*

Group	Mean Difference	SD	SE	95% CI Lower	95% CI Upper	t	df	P-value	Decision	Interpretation
Experimental Group	-19.83	9.89	1.12	-22.06	-17.60	-17.71	77	< .001	Reject Ho	Significant
Control Group	-21.91	9.69	1.11	-24.11	-19.71	-19.83	76	< .001	Reject Ho	Significant

Table 2 presents the paired-samples t-test results comparing the pretest and posttest scores of the control and experimental groups. The findings revealed statistically significant differences between the pretest and posttest scores in both groups. The experimental group obtained a computed t-value of -17.71 with a p-value of < .001, while the control group yielded a computed t-value of -19.83 with a p-value also < .001. Since the computed p-values were lower than the 0.05 significance level, the null hypothesis was rejected.

These results indicate that both instructional approaches significantly improved mathematics performance. The significant increase in posttest scores suggests that students gained substantial learning after exposure to the lessons and instructional activities provided during the intervention period.

The findings support the view that effective instruction, regardless of teaching approach, contributes positively to mathematics achievement. Consistent with Chetty et al. (2019), instructional strategies and classroom delivery play an important role in promoting student understanding and academic performance. Similarly, Adu and Duku (2021) emphasized that responsive instructional practices may enhance learners' engagement and achievement in Mathematics.

Table 3. Comparison of the Pretest, Posttest, and Mean Gain Scores Between the Control and Experimental Groups $N = 155$

Variable	Group	n	Mean	SD	P value	Decision	Interpretation
Pretest Scores	Experimental Group	78	36.18	7.62	.397	Failed to Reject Ho	Not Significant
	Control Group	77	35.66	8.60			
Posttest Scores	Experimental Group	78	56.01	11.38	.342	Failed to Reject Ho	Not Significant
	Control Group	77	57.57	12.62			
Mean Gain Scores	Experimental Group	78	19.83	9.89	.189	Failed to Reject Ho	Not Significant
	Control Group	77	21.91	9.69			

Table 3 presents the comparison of the pretest, posttest, and mean gain scores between the control and experimental groups. The findings revealed no statistically significant differences between the two groups across all measures. In the pretest, the experimental group obtained a mean score of 36.18 (SD = 7.62), while the control group recorded a mean score of 35.66 (SD = 8.60). The computed p-value of .397 exceeded the 0.05 level of significance, indicating that both groups had comparable levels of mathematical knowledge prior to the intervention.

Similarly, the posttest results showed no statistically significant difference between the groups. Although the control group obtained a slightly higher mean score ($M = 57.57$, $SD = 12.62$) than the experimental group ($M = 56.01$, $SD = 11.38$), the computed p-value of .342 indicated that the difference was not significant. This suggests that both conventional teaching and learning style-based instruction were similarly effective in improving students' mathematics performance.

In terms of mean gain scores, the control group showed a slightly higher gain ($M = 21.91$, $SD = 9.69$) than the experimental group ($M = 19.83$, $SD = 9.89$). However, the computed p-value of .189 showed that the difference in learning gains between the two groups was likewise not statistically significant. The findings indicate that although both instructional approaches contributed positively to students' achievement, aligning instruction with students' preferred learning styles did not result in significantly greater improvement in mathematics performance.

The results support the findings of Kohan et al. (2021) and Yilmaz et al. (2016), which reported that learning styles alone do not significantly determine students' academic achievement. The findings further imply that instructional quality, learner motivation, teacher effectiveness, and classroom interaction

may play more substantial roles in enhancing mathematics performance than learning styles alone.

Table 4. *Posttest Scores of the Experimental Group According to Learning Style*
n = 78

Learning Style	f	Mean	SD
Reflector	41	54.59	10.70
Activist	5	60.40	13.05
Theorist	9	60.67	15.41
Pragmatist	8	54.50	11.93
Reflector and Pragmatist	8	57.13	9.17
Activist and Pragmatist	2	59.50	6.36
Activist and Theorist	3	58.00	17.69
Reflector and Theorist	2	48.50	0.71
Total	78	56.01	11.38

Table 4 presents the posttest scores of the experimental group according to learning style preference. The findings revealed that the reflector learning style was the most prevalent among the participants, comprising 41 students (52.56% of the respondents). This was followed by theorists (11.54%) and pragmatists (10.26%). Some students also exhibited combinations of learning styles, indicating that learners may not exclusively rely on a single learning preference.

Among the identified learning styles, theorists obtained the highest mean posttest score ($M = 60.67$, $SD = 15.41$), followed closely by activists ($M = 60.40$, $SD = 13.05$). Meanwhile, students classified as reflector and theorist recorded the lowest mean score ($M = 48.50$, $SD = 0.71$). Despite these variations, the mean scores across learning styles remained relatively comparable.

The findings suggest that students possess diverse learning preferences, with many learners demonstrating characteristics of multiple learning styles. The dominance of the reflector learning style suggests that students tend to prefer observing, reflecting on, and analyzing information before making conclusions or decisions. This finding supports the study of Guraya (2014), which likewise identified reflector-oriented learning preferences as common among students in academic settings.

Table 5. *Variance in the Posttest Scores According to Learning Style of the Experimental Group*

Source of Variation	Sum of Squares	df	Mean Square	F	P-value	Decision	Interpretation
Between Groups	551.96	7	78.85	0.587	.765	Failed to Reject Ho	Not Significant
Within Groups	9411.03	70	134.44				
Total	9962.99	77					

Table 5 presents the analysis of variance (ANOVA) of the experimental group's posttest scores by learning style. The computed F-value of 0.587 with a p-value of .765 exceeded the 0.05 level of significance, indicating that there was no statistically significant variance in posttest scores among the different learning style groups. Consequently, the null hypothesis was not rejected.

The findings indicate that students' preferred learning styles did not significantly influence their mathematics performance. Although slight differences in mean scores were observed across learning styles, these variations were insufficient to establish statistical significance. This suggests that students may achieve comparable mathematics performance regardless of their dominant learning preference.

The result is consistent with the findings of Yilmaz et al. (2016), who concluded that learning style preferences do not significantly affect academic achievement in mathematics. The findings suggest that classroom environment, learner engagement, and instructional quality may contribute more substantially to mathematics achievement than learning styles alone.

CONCLUSIONS

Based on the study's findings, both the conventional teaching approach and the learning-style-based instructional approach significantly improved the mathematics performance of Grade 11 students. The control and experimental groups both demonstrated substantial increases in posttest scores, indicating that effective instruction positively contributed to students' learning and achievement in General Mathematics.

The investigation indicated no significant disparity between the pretest and posttest results of the control and experimental groups. The study revealed no significant differences between the pretest and posttest performances of the control and experimental groups. Likewise, no significant differences were observed in mean gains between the two groups, indicating that aligning instruction with students' preferred learning styles did not yield significantly higher mathematics achievement than conventional teaching approaches.

Nonetheless, the analysis of variance revealed no significant differences in posttest scores among the learning-style categories. This suggests that pupils'

preferred learning approaches did not substantially affect their mathematics performance.

The findings indicate that although learning styles may enhance classroom engagement and learner responsiveness, they are not the exclusive factors influencing academic success in Mathematics. Additional factors, including instructional quality, instructor proficiency, student motivation, and classroom atmosphere, may significantly influence improvements in students' mathematics performance.

RECOMMENDATIONS

Based on the study's findings, the researcher proposes the following recommendations.

1. Diagnosing the personal learning styles must be taken seriously into account to ensure that we get the accurate learning style of the students, as it will be the basis for the conduct of the discussion and assessment. In turn, the results must also be integrated into class discussions.

2. After each discussion on the topics, an application or assessment must take place to test the students' learning.

3. The posttest should be utilized to assess the students' learning and should serve as a guide to determine the next course of action.

4. Teachers must be observed and monitored more frequently by coordinators to ensure that they have clearly delivered their lessons well.

5. The school may hold seminars and trainings that will discuss strategies and styles in responding to student diversity. This will help the instructors deliver better instruction suited to their students' needs.

6. Mathematics teachers should acknowledge the students with low performance in class and create alternative methods to cater to their learning needs while still basing on the MELCs framework.

7. The students may be encouraged by the mathematics teachers to form math organizations and participate in activities that may enhance their learning styles. The department must ensure the sustainability of these math-related organizations once established. There must be timely documentation of progress to track development and create programs to support each student's distinct abilities.

8. Mathematics teachers should make the best use of their utilization of diverse teaching styles and procedures to meet the learning needs of the students, in view of the preferred learning styles.

9. Other researchers may take a follow-up study based on this idea to verify the findings of this study. A study may be conducted to determine the relationship between instructors' teaching styles, students' learning styles, and students' classroom performance.

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