

**EFFECTIVENESS OF A GAISE-II ALIGNED FLIPPED CLASSROOM IN TEACHING MEASURE OF VARIABILITY****\*Junry P. Bacalso and Fe R. Janiola**

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**Abstract**

This study examined the effectiveness of a GAISE II-aligned flipped classroom in improving Grade 8 students' performance of measures of variability, specifically range, mean deviation, variance, and standard deviation. Using quasi-experimental pretest-posttest design, 50 students from two intact sections were assigned as either control or experimental groups. Baseline results confirmed that both groups had comparable prior knowledge, with no significant difference in pretest scores. Following a four-week intervention, both groups showed statistically significant improvement; however, the experimental group demonstrated greater learning gains. Paired samples t-test results revealed a higher mean increase and a very large effect size in the experimental group compared to the control group, while independent samples t-test results indicated a significant difference in posttest scores favoring the flipped classroom, with a moderate to large effect size. The integration of the flipped classroom with the GAISE II framework facilitated student-centered learning by shifting content delivery outside the classroom and maximizing in-class time for collaborative problem-solving, inquiry-based activities, and data interpretation. These findings indicate that the approach enhances both procedural skills and conceptual understanding, particularly in statistical reasoning. The study provides empirical evidence supporting the adoption of innovative, inquiry-driven instructional strategies in mathematics education and highlights the importance of aligning pedagogy with established statistical frameworks to improve learning outcomes in contexts of low mathematics proficiency.

**Keywords:** Flipped Classroom, GAISE II Framework, Measures of Variability, Mathematics Achievement.

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**INTRODUCTION**

Mathematics education is still a critical domain for developing logical reasoning, analytical thinking, critical thinking skills, and which are necessary competencies in the 21st-century knowledge economy (Dela Peña & Doronio, 2025; OECD, 2019). Despite this significance, Filipino students continue to face challenges in mathematics, as showed by the 2022 PISA results, where the Philippines ranked near the bottom among 81 participating countries, with only 16% of students achieving minimum proficiency levels (OECD, 2022; 2023). These results highlight systemic deficiencies in teaching practices and underscore the urgent need for innovative pedagogical approaches that can bridge learning gaps and enhance conceptual understanding. One promising approach is the Flipped Classroom Approach (FCA), which inverts traditional instruction by delivering foundational content outside the classroom through videos or digital lessons, enabling in-class time to be devoted to interactive problem-solving, discussions, and collaborative learning (Jeong *et al.*, 2021; Francisco, 2021). Existing studies suggest that FCA can improve engagement, critical thinking, and academic performance in mathematics (Alviar & Solon, 2023; Cevikbas & Kaiser, 2023), yet the majority rely on pre-post designs without control groups, limiting the ability to draw causal conclusions. Addressing this methodological gap is vital to understand whether FCA, when systematically aligned with educational standards like the GAISE II framework, can significantly enhance students' understanding of statistical concepts such as measures of variability. The GAISE II framework emphasizes statistical reasoning, data literacy, and the interpretation of real-world data through inquiry-based, student-centered learning (Franklin *et al.*, 2022). By integrating FCA with GAISE II principles, learners can first explore foundational

concepts asynchronously, allowing them to process content at their own pace, before applying knowledge to authentic problem-solving tasks in the classroom (Erhardt & Lim, 2020). This alignment is particularly significant for the teaching of measures of variability range, mean deviation, variance, and standard deviation which are essential for understanding the dispersion of data beyond mere averages (Chaphalkar, 2020; Shaughnessy *et al.*, 2020; Pascual, 2025). Developing competency in these concepts not only enhances statistical literacy but also cultivates higher-order thinking and evidence-based decision-making skills. Empirical research supports the efficacy of FCA in improving performance in mathematics, including statistics, by fostering active engagement, immediate feedback, and collaborative problem-solving opportunities (Inayah *et al.*, 2023; Baybayan & Cabanes, 2024; Bernas, 2024). Nevertheless, challenges such as technological accessibility, teacher readiness, and consistent student acceptance remain critical for successful implementation (Nugraheni *et al.*, 2022; Sarker *et al.*, 2023). By adopting a rigorous comparative design that includes both treatment and control groups, this study seeks to evaluate the effectiveness of a GAISE-II-aligned flipped classroom in teaching measures of variability among Grade 8 students. This research not only addresses the national need for improved mathematics achievement but also contributes evidence-based insights into pedagogical practices capable of preparing students for advanced study, informed citizenship, and data-driven decision-making in a rapidly evolving society.

**METHODOLOGY**

This study employed a quasi-experimental research design using the pretest-posttest control group method to determine the effectiveness of the Flipped Classroom Approach in improving Grade 8 students' mathematics performance in Measures of Variability. This design was appropriate because

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the study aimed to compare the academic performance of learners exposed to the flipped classroom approach and those taught using standard classroom instruction. Prior to the intervention, both groups were administered a pretest to establish baseline performance and determine comparability between the groups. To ensure impartial group assignment, a coin toss was conducted once to randomly choose which section would serve as the experimental group and which would serve as the control group. The intervention was implemented during the fourth quarter, after which a posttest was administered to measure learning gains and figure out whether a significant difference existed between the two instructional approaches.

The study was conducted at Policronio S. Dano Sr. High School, a medium-sized public secondary school located in Nueva Fuerza, Carmen, Bohol, offering both junior and senior high school programs. This research site was selected because it was among the schools assessed in the PISA 2022 evaluation, where results revealed low mathematics performance. Conducting the study in this setting offered a relevant opportunity to explore the potential of innovative teaching strategies such as the flipped classroom approach in addressing learning gaps and improving students' achievement in mathematics. The participants of the study consisted of 50 Grade 8 students enrolled in Mathematics 8 during the fourth quarter of School Year 2025–2026. Respondents came from two intact sections: Section A (25 students) and Section B (25 students). Complete enumeration was used, meaning all students from both sections were included. Based on the coin toss result, Section A was assigned as the control group (standard classroom instruction), while Section B served as the experimental group (GAISE-II aligned flipped classroom). Pretest scores were used to establish baseline equivalence, and statistical analysis was conducted to confirm that neither group had an initial performance advantage. Ethical considerations were strictly seen through voluntary participation, informed consent from parents, learner assent, and confidentiality of all collected data.

### **Instructional Materials and Intervention**

The instructional materials and intervention used in this study were designed to evaluate the effectiveness of a GAISE-II aligned Flipped Classroom in teaching measures of variability for ungrouped data among Grade 8 learners. The study covered key topics including range, mean deviation, variance, and standard deviation, with emphasis not only on computation but also on interpretation and drawing conclusions from statistical data. To ensure content consistency across groups, the researcher utilized the DepEd Lesson Exemplar for Mathematics 8 (Weeks 1–2) developed under the implementation of the MATATAG K to 10 Curriculum for School Year 2025–2026. This exemplar, authored by Agapay (2024) and validated by Cardona (2024) under the supervision of the Philippine Normal University Research Institute for Teacher Quality and the SiMERR National Research Centre, served as the primary instructional reference for both the control and experimental groups. For the control group, the DepEd exemplar was strictly followed using standard classroom instruction. For the experimental group, the researcher developed a flipped classroom lesson plan integrated with the GAISE II statistical problem-solving process, ensuring inquiry-based learning through statistical questioning, data analysis, and interpretation. The lesson plan,

together with learner's guide, activity sheets, and selected video tutorials, underwent validation by mathematics experts prior to implementation. Results of the validation indicated that the instructional materials were Highly Valid, with composite means of 3.85 for the learner's guide and activity sheets, 3.83 for the lesson plan, and 3.93 for video tutorials, confirming strong alignment with curriculum standards, flipped classroom principles, and GAISE II processes.

The primary research instrument used to measure students' academic performance was a researcher-made test questionnaire administered as both pretest and posttest. The development of the instrument followed a systematic process to ensure validity and reliability. First, a Table of Specifications was constructed to guide test development and ensure alignment with the Department of Education Curriculum Guide and MELCs. Initially, a 60-item test was prepared and submitted to the thesis adviser for evaluation and refinement. After revisions, the questionnaire was subjected to content validation by eight Mathematics teachers using the Content Validity Index (CVI), resulting in the reduction of items from 60 to 30. Reliability was established using the test-retest method, wherein the same instrument was administered twice to the same group of Grade 9 students at different times, and the results were correlated. Pilot testing was also conducted with Grade 9 learners who had already mastered the competencies to assess clarity and effectiveness of the items. Item analysis showed that the final 20-item test met acceptable standards in difficulty and discrimination. Ten items were classified as easy, eight as moderate, and two as difficult, providing balanced cognitive coverage. Discrimination indices ranged from 0.33 to 0.67, interpreted as very good. The finalized instrument demonstrated excellent content validity with an I-CVI of 1.00, S-CVI/Ave of 1.00, and acceptable reliability with a Pearson correlation coefficient of  $r = 0.795$ , confirming its suitability for assessing student learning outcomes in the intervention.

The intervention was implemented over a four-week period, guided by an implementation matrix that ensured systematic delivery of lessons. Week 1 focused on orientation, distribution of consent forms, and administration of the pretest to both groups. Weeks 2 and 3 covered the computation and interpretation of measures of variability. In the control group, lessons followed teacher-led instruction using the DepEd exemplar through guided examples, seatwork, and direct discussion. In contrast, the experimental group followed the GAISE-II aligned flipped classroom. Students studied lesson content at home through validated video tutorials and printed materials, completed guided notes, and performed readiness tasks prior to class sessions. Classroom time was devoted to student-centered activities such as collaborative problem-solving, small group investigations, peer discussions, retrieval practice, and contextual applications using real-life datasets. The teacher served mainly as a facilitator by clarifying misconceptions, providing feedback, and promoting higher-order reasoning. Week 4 consisted of the administration of the posttest for both groups and the distribution of an acceptability questionnaire for the experimental group. To measure students' acceptance of the flipped classroom approach, the study adapted an instrument from Cabero-Almenara et al. (2021). The questionnaire demonstrated strong psychometric properties, with Cronbach's alpha values exceeding 0.70 across all constructs and evidence of convergent and

discriminant validity, confirming its appropriateness in assessing learner perceptions of the intervention.

## RESULTS AND DISCUSSION

The study investigated the effectiveness of a GAISE-II aligned Flipped Classroom Approach in teaching measures of variability for ungrouped data among Grade 8 learners in Mathematics 8. The results indicated a measurable improvement in students' academic performance after the implementation of the intervention. As shown in table 1, the distribution of respondents' test score performances in the control group (standard instruction) and experimental group (GAISE-II aligned flipped classroom) before and after the intervention. During the pre-test, all respondents in both the control group (100%) and experimental group (100%) were classified under the Beginning level, with an average transmuted grade of 68 for both groups. This indicates that the two groups had comparable baseline performance prior to the implementation of the instructional strategies. After the intervention, improvements were observed in both groups; however, the experimental group demonstrated greater progress. In the control group, most learners remained at the Beginning level (64%), while only a few moved to higher levels such as Approaching Proficiency (20%), Developing (4%), Proficient (4%), and Advanced (8%), resulting in an average transmuted grade of 75, interpreted as Approaching Proficiency. In contrast, the experimental group showed a stronger shift toward higher performance levels, with only 28% remaining at the Beginning level, while larger proportions reached Developing (36%), Proficient (8%), and Advanced (20%). Although fewer learners fell under Approaching Proficiency (8%), the greater concentration of students in the Developing to Advanced levels reflects stronger overall performance. Consequently, the experimental group obtained a higher average transmuted grade of 81, interpreted as Developing, suggesting that students exposed to the GAISE-II aligned flipped classroom approach achieved better learning outcomes in measures of variability for ungrouped data compared to those who received standard classroom instruction. These results imply that the flipped classroom approach contributed positively to improving students' academic performance (Alviar & Solon, 2023).

Table 2 presented the results of the paired samples t-test used to determine whether there was a significant difference in the test score performance of students within each group before and after the implementation of the intervention. For the experimental group exposed to the GAISE-II aligned flipped classroom approach, the post-test mean score ( $M = 13.48$ ,  $SD = 3.78$ ) was substantially higher than the pre-test mean score ( $M = 6.88$ ,  $SD = 1.81$ ), resulting in a mean difference of 6.60. Statistical analysis showed that this improvement was highly significant,  $t(24) = 9.66$ ,  $p < .001$ , with a very large effect size (Cohen's  $d = 1.93$ ). Similarly, the control group that received standard instruction also showed improvement from the pre-test ( $M = 6.52$ ,  $SD = 1.94$ ) to the post-test ( $M = 10.76$ ,  $SD = 3.39$ ), with a mean difference of 4.24, which was also statistically significant,  $t(24) = 6.87$ ,  $p < .001$ , with a large effect size (Cohen's  $d = 1.37$ ). Since the obtained p-values for both groups are less than the significance level of .05, the null hypothesis was rejected in both cases. These results indicate that both instructional approaches significantly improved students' test score performance in measures of variability for ungrouped data; however, the larger mean gain and stronger effect size observed in the experimental group suggest that the flipped classroom approach led to greater improvement compared with the standard instructional method. These findings align with studies showing significant pre-post gains in flipped mathematics classes (Baybayan & Cabanes, 2024; Oyebanji & Adebisi, 2025), although some reviews report inconsistencies due to variations in research design (Cevikbas & Kaiser, 2023).

Table 3 showed the results of the independent samples t-test conducted to determine whether a significant difference existed between the experimental and control groups prior to the implementation of the intervention. The pre-test mean score of the experimental group ( $M = 6.88$ ,  $SD = 1.81$ ) was slightly higher than that of the control group ( $M = 6.52$ ,  $SD = 1.94$ ); however, the difference was not statistically significant,  $t(49) = 0.679$ ,  $p = .501$ , with a small effect size (Cohen's  $d = 0.192$ ). Since the obtained p-value is greater than the significance level of .05, the null hypothesis was not rejected. This result indicates that there was no significant difference in the initial test score performance of students in the experimental and control groups before the intervention.

**Table 1. Test score performances of respondents in both classroom standard Instruction and GAISE-II aligned flipped classroom before and after the implementation of the intervention**

Descriptor	Grade	Before				After			
		Control		Experimental		Control		Experimental	
		f	%	f	%	f	%	f	%
Advanced	90-100	-	-	-	-	2	8%	5	20%
Proficient	85-89	-	-	-	-	1	4%	2	8%
Developing	80-84	-	-	-	-	1	4%	9	36%
Approaching Proficiency	75-79	-	-	-	-	5	20%	2	8%
Beginning	< 75	25	100%	25	100%	16	64%	7	28%
Average Transmuted Grade		68		68		75		81	
Description		Beginning		Beginning		Approaching Proficiency		Developing	

**Table 2. Significant difference in test score performance within each group before and after the implementation of the intervention**

Group	Test	Mean	SD	Mean Diff.	t-value	df	p-value	Effect Size	Decision	Interpretation
Experimental	Post-Test	13.48	3.78	6.60	9.66	24.0	0.000	1.93	Reject Ho	Significant
	Pre-Test	6.88	1.81							
Control	Post-Test	10.76	3.39	4.24	6.87	24.0	0.000	1.37	Reject Ho	Significant
	Pre-Test	6.52	1.94							

**Table 3. Significant difference in test score performance between the standard Instruction and GAISE-II aligned flipped classroom groups before the implementation of the intervention**

Group	Mean	SD	t-value	df	p-value	Effect Size	Decision	Interpretation
Experimental	6.88	1.81	0.679	49	0.501	0.192	Fail to reject Ho	No Difference
Control	6.52	1.94						

**Table 4. Significant difference in test score performance between the standard Instruction and GAISE-II aligned flipped classroom groups after the implementation of the intervention**

Group	Mean	SD	t-value	Df	p-value	EffectSize	Decision	Interpretation
Experimental	13.5	3.78	2.68	49	0.010	0.758	Reject Ho	Significant
Control	10.8	3.39						

Therefore, it can be inferred that both groups had comparable prior knowledge of the measures of variability for ungrouped data, suggesting that the groups were relatively equivalent at baseline before the flipped classroom approach was implemented (Oyebanji & Adebisi, 2025).

Table 4 depicted the results of the independent samples t-test conducted to determine whether a significant difference existed between the traditional instruction group and the flipped classroom group after the implementation of the intervention. The post-test results show that the experimental group obtained a higher mean score ( $M = 13.50$ ,  $SD = 3.78$ ) compared to the control group ( $M = 10.80$ ,  $SD = 3.39$ ). Statistical analysis revealed that this difference was significant,  $t(49) = 2.68$ ,  $p = .010$ , with a moderate to large effect size (Cohen's  $d = 0.758$ ). Since the obtained p-value is less than the significance level of .05, the null hypothesis was rejected. This indicates that there was a statistically significant difference in the test score performance of students between the two groups after the intervention. The magnitude of the effect suggests that the GAISE-II aligned flipped classroom had a meaningful practical impact on students' performance. These findings are consistent with national studies where flipped classroom strategies outperformed standard classroom instruction (Alviar & Solon, 2023; Baybayan & Cabanes, 2024; Oyebanji & Adebisi, 2025), although some reviews report variability in outcomes due to limitations in rigorous control-group designs (Nugraheni *et al.*, 2022).

## Conclusion

This study highlights the effectiveness of integrating the GAISE-II framework with the Flipped Classroom Approach (FCA) in improving students' understanding of measures of variability in Mathematics. Addressing the persistent issue of low mathematics performance among Filipino learners, the findings demonstrate that innovative, student-centered instructional strategies can significantly enhance both conceptual understanding and academic achievement. By shifting content delivery outside the classroom and maximizing in-class time for collaborative problem-solving, inquiry-based learning, and data interpretation, the flipped classroom created a more engaging and cognitively supportive learning environment. Although both the standard instruction and flipped classroom groups showed statistically significant improvements from pretest to posttest, the experimental group consistently achieved higher mean scores, greater learning gains, and stronger effect sizes, indicating a more substantial impact on student learning. The lack of significant differences in pretest performance confirmed that both groups were comparable at baseline, strengthening the validity of the results.

Moreover, the moderate to large between-group effect size and the very large within-group improvement in the experimental group emphasize that the GAISE-II aligned flipped classroom approach not only produced statistically significant outcomes but also yielded meaningful practical benefits in enhancing students' statistical reasoning and performance. These findings suggest important implications for educational practice, as teachers are encouraged to adopt blended, inquiry-driven approaches that promote active learning, critical thinking, and deeper conceptual understanding rather than rote procedures. At the curricular level, integrating GAISE-II principles with flipped learning structures can improve the teaching of complex statistical concepts, while at the policy level, support for teacher training, digital resources, and instructional innovation is essential for successful implementation. Future research may further examine the long-term retention of learning, the transferability of statistical skills across contexts, and the influence of factors such as technology access, learner motivation, and teacher implementation fidelity to optimize and sustain the effectiveness of this approach across diverse educational settings.

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