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## Enhancing Conceptual Understanding in Geometry through Journal Writing: A Case from One Philippine Secondary School

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### ABSTRACT

Traditional assessment practices in Mathematics often stress procedural recall over conceptual understanding, limiting students' opportunities for reflective engagement with abstract ideas. Reacting to this concern, the present study examined the effectiveness of journal writing as an alternative assessment tool for promoting students' understanding of Geometry concepts. Anchored on constructivist and metacognitive learning perspectives, a quasi-experimental pretest–posttest design was employed with two intact Grade 10 classes from a public secondary school in South Cotabato, Philippines. The experimental group utilized journal writing to record reasoning processes, reflections, and conceptual insights, while the control group was assessed using conventional paper-and-pencil tests. Data were gathered through validated pretests and posttests as well as open-ended questionnaires. Quantitative results indicated that the experimental group got significantly higher mean gain scores than the control group, showing the positive impact of journal writing on students' conceptual growth. Thematic analysis of qualitative responses further disclosed that journal writing improved learners' comprehension of geometric principles, sustained memory retention, and promoted reflective thinking. Taken together, these findings present empirical proof that journal writing constitutes a meaningful mode of alternative assessment, augmenting traditional measures and encouraging deeper engagement in Mathematics classrooms.

### INTRODUCTION

Assessment has long been acknowledged as a cornerstone of education, forming not only how student learning is evaluated but also how instruction is designed and delivered. Globally, however, assessment practices have often been critiqued for emphasizing standardized tests, procedural recall, and rote memorization at the expense of conceptual understanding and higher-order thinking (Campbell *et al.*, 1998; Adams, 1998). This concern is particularly pressing in mathematics education, where conventional paper-and-pencil tests typically measure factual recall rather than students' reasoning, reflection, and capacity to solve complex problems. Such practices limit opportunities for learners to engage in metacognition and meaning-making, both of which are critical for long-term mathematical proficiency.

Across Asia, education systems have grappled with balancing traditional summative testing and innovative assessment approaches. High-performing systems such as Singapore, China, and Hong Kong have gradually integrated authentic and alternative assessments like journals, portfolios, and project-based tasks into classroom practice to foster deeper learning (Koh & Luke, 2009; Koh *et al.*, 2012; Brown & Gao, 2015). Research in East Asian contexts highlights that assessment for learning, when effectively implemented, strengthens reflective thinking, student agency, and conceptual understanding, moving beyond the narrow scope of test-driven accountability (Leong *et al.*, 2018). Similarly, in Vietnam, efforts to promote alternative assessments in higher education

have underscored their potential to develop critical and communicative competencies despite systemic challenges (Duong, 2020; Duyen & Nghia, 2024).

Within Southeast Asia, the Association of Southeast Asian Nations (ASEAN) has increasingly emphasized educational reforms aligned with global competitiveness and sustainable development goals. Comparative studies note that while systems in Singapore and Malaysia have made significant strides toward embedding authentic assessment into pedagogy, many other ASEAN countries remain anchored to conventional, examination-driven practices (Wang & Lin, 2005; Tan, 2018). This unevenness poses risks to equity and inclusivity, particularly when students are denied opportunities to engage in reflective learning experiences that cultivate problem-solving and reasoning.

The Philippine context shows this wider regional tension. Despite curricular reforms under K to 12, assessment in mathematics classrooms remains largely summative and test-based. Evidence from the 2022 Programme for International Student Assessment (PISA) indicated that Filipino students ranked among the lowest in mathematics, raising concerns about the country's reliance on evaluation practices that prioritize memorization over understanding (OECD, 2023). Recent studies also point to the persistent lack of reflective and process-oriented assessments, which deprives learners of chances to articulate reasoning, confront misconceptions, and internalize mathematical concepts (De Dios *et al.*, 2023). This challenge is particularly prominent in geometry, a

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domain widely held as difficult due to its abstract nature and reliance on visualization, logical reasoning, and proof (Demircioglu & Hatip, 2023; Jablonski & Ludwig, 2023). Students often struggle with geometric concepts, and without platforms to document their reasoning, misconceptions remain unaddressed (Chiphambo & Feza, 2020; Martinovic & Manizade, 2018).

Locally, there is limited evidence of systematic integration of alternative assessments such as journal writing in mathematics. While international scholarship proves that reflective writing tasks can enhance mathematical reasoning, metacognitive awareness, and communication (Yeo & Fan, 2003; McAllister, 2013; Powell *et al.*, 2017), such practices remain underexplored in Philippine classrooms. This gap stresses the need for empirical studies that investigate how journal writing as an assessment tool may strengthen conceptual understanding of geometry among Filipino learners.

This study responds to this gap by examining the use of journal writing as an alternative assessment strategy in one Philippine secondary school. Specifically, it seeks to determine whether journal writing enhances students' conceptual understanding of geometry by encouraging reflection, error analysis, and meaning-making. In doing so, it aligns with the United Nations Sustainable Development Goal 4 (SDG 4), which calls for inclusive and equitable quality education and lifelong learning opportunities for all (United Nations, 2015). By encouraging reflective, process-oriented learning, this research contributes to efforts aimed at equipping learners with the reasoning, analytical, and problem-solving skills required in a knowledge-based society.

### Conceptual Framework

The conceptual basis of this study is anchored on the notion that assessment should work as both a measure and a means of learning. Traditional assessments aim largely on evaluating student performance but often neglect the processes that lead to deeper understanding. By contrast, alternative assessments like journal writing inspire learners to articulate their reasoning, reflect on their errors, and restructure knowledge in ways that raise metacognitive awareness and conceptual growth (Martin, 2015; Powell *et al.*, 2017; Mejares & Tan, 2023).

Journal writing, when utilized in a mathematics classroom, permits students to document not only their answers but also their problem-solving strategies, errors, and insights. This reflective process complements with the constructivist view that learners actively construct knowledge through interaction with tasks and reflection on their experiences. It also reaffirms Flavell's (1979) metacognitive theory, which features the value of monitoring and controlling one's thinking processes in learning. Prior studies in mathematics classrooms have disclosed that writing tasks from reflective journals to proof-based expositions facilitate students to polish their reasoning and improve mathematical communication (Yeo & Fan, 2003; McAllister, 2013).

Despite its proven benefits in various contexts, the use of journal writing in secondary geometry classrooms remains underexplored, particularly in the Philippine setting. This gap explains the present study, which sets journal writing as an alternative assessment strategy to enhance students' conceptual understanding of geometry.

### Objective of the Study

The primary objective of this study is to investigate the impact of journal writing as an alternative assessment tool on the understanding of selected geometry lessons among Grade 10 students. Specifically, it seeks to answer the following research questions:

1. What is the level of understanding of students in geometry lessons when exposed to journal writing compared with traditional assessments in the pretest and posttest?
2. Is there a significant difference between the pretest and posttest scores of students in the control group?
3. Is there a significant difference between the pretest and posttest scores of students in the experimental group (journal writing)?
4. Is there a significant difference between the mean gain scores of students in the control and experimental groups?
5. What are the perceptions of students toward the use of journal writing as an assessment tool in geometry?

### LITERATURE REVIEW

Conceptual understanding has long been regarded a principal goal of mathematics education, distinguishing it from common procedural fluency. It involves understanding the meaning of mathematical ideas, their interrelations, and the ability to apply them in diverse contexts (Niemi, 1996; Greene & Shorter, 2017). In geometry, this element of learning becomes particularly critical as students are presumed not only to memorize formulas but also to visualize, analyze, and logically reason about spatial relationships. Research has shown that challenges in geometric learning often stem from weak conceptual foundations, particularly in areas such as proofs and transformations (Malatjie & Machaba, 2019; McCrone & Martin, 2004). To address these issues, scholars have explored innovative approaches including visual media (Tundreng, 2025) and dynamic software such as GeoGebra and Geometer's Sketchpad, which have demonstrated potential in deepening students' reasoning and engagement in geometry (Abakah & Brijlall, 2024; Ames, 2011). However, while technological tools have gained distinction, there is increasing recognition of the role of reflective discourse through language and writing as equally powerful strategies for promoting deeper learning (Nachowitz, 2019).

Writing in mathematics, particularly journal writing, has been viewed as a metacognitive strategy that assists learners to express their reasoning, defy misconceptions, and merge conceptual understanding. Studies have consistently cited that written reflection drives students

to externalize their thought processes, making their reasoning evident both to themselves and to teachers (Martin, 2015; Stonewater, 2002). Classroom journals, for example, have been shown to inspire students to expound concepts in their own words and to relate procedures with underlying ideas (Camahalan & Young, 2015). Synthesis studies such as Powell and colleagues (2017) stressed that journaling enables conceptual learning by associating cognitive processes with written expression. Furthermore, Nachowitz (2019) claimed that writing tasks are mostly effective when they oblige students to justify, explain, or critique mathematical ideas rather than simply describe them. At higher levels of learning, conceptual writing activities have also been noted to influence not just performance but also students' attitudes toward mathematics (Van Dyke, Malloy, & Stallings, 2015), signifying that writing serves both cognitive and affective purposes in mathematics classrooms.

Empirical proof explicitly relating journal writing and conceptual understanding is likewise conclusive. In Singapore, Tan and Garces-Bacsal (2013) confirmed that high-ability students attained higher levels of mathematics performance when they employed reflective journals, while Hirschfeld-Cotton (2008) underscored that journal writing improves both mathematical communication and conceptual understanding. Classic studies such as Jurdak and Abu Zein (1998) also showed improvements in knowledge and attitudes toward mathematics when writing was incorporated into instruction. More recently, Barr (2023) confirmed the continuing value of journal writing, mainly when aligned with instructional goals and feedback mechanisms. In the Philippine context, Raga-Abee (2022) cited that Grade 11 students' conceptual understanding in mathematics enhanced significantly when journal writing was instituted, with students themselves stating that the practice aided them simplify concepts and make meaningful links between procedures and ideas. Such findings uphold the potential of journal writing as a reflective tool for enhancing learning outcomes across diverse cultural and curricular settings. Research on geometry has fed further insight into how reflective and alternative forms of assessment can brace students' conceptual underpinnings. Weldeana and Sbhatu (2017), for instance, proved that portfolios of written explanations upgraded conceptual understanding and achievement in geometry among teacher education students, while Omar *et al.* (2018) divulged that peer assessments promoted deeper comprehension beyond procedural mastery. Corresponding innovations such as the integration of visual media (Tundreng, 2025) and solid geometry learning packages (Amarulloh *et al.*, 2025) likewise reflect that conceptual understanding in geometry can be meaningfully enhanced when learners are given chances to articulate reasoning through multiple representations, including writing. These findings collectively support the notion that journal writing in geometry should not be regarded in isolation but as part of a wider pedagogical context that values reflection,

representation, and critical discourse.

In the Philippines, numerous studies have pointed out the continued challenge of developing conceptual understanding in mathematics, particularly geometry. Solaiman and Bonsalagan (2017) surveyed the van Hiele levels of secondary students in Lanao del Sur and found that many remained at the lower visualization and analysis stages, a judgement that is validated in Bautista and Valtoribio's (2016) assessment of the Grade 8 geometry teaching guide under the K to 12 curriculum, which showed gaps in responding to students' developmental readiness. Efforts to integrate alternative assessment approaches have generated promising results. Lao and Divinagracia (2022) cited that a theory-based alternative assessment enriched both metacognitive awareness and performance of Grade 8 learners, while Bautista (2018) noted the effectiveness of error analysis as a formative assessment tool for improving retention of geometry concepts. More recently, Saavedra *et al.* (2023) proved that contextualized learning materials in analytic geometry upheld satisfactory levels of conceptual understanding among students notwithstanding the challenges of remote learning.

The recognition that traditional practices in Philippine classrooms often prefer procedural skills over conceptual depth has further urged calls for innovative strategies. Cerado (n.d.) noted the scarcity of local literature devoted exclusively to mathematics assessment and pointed to the urgent need for frameworks that balance procedural fluency with conceptual growth. Casanova and colleagues (2021) similarly stressed that Filipino students' geometric thinking, particularly on foundational concepts such as triangles, requires significant improvement, while Mercado, Sy, and Ambay (2024) responded with the development of an instructional learning package that enhanced conceptual understanding and engagement in geometry. Together, these studies reveal a local context marked by both persistent challenges and creative efforts to address them, underscoring the relevance of reflective and alternative approaches to assessment.

Overall, the literature asserts that journal writing encourages reflection, communication, and deeper conceptual understanding in mathematics, including geometry. International studies confirm its efficacy across various levels and situations, while local research features the continuing challenges Filipino students confront in developing sound conceptual understanding of geometry and the encouraging role of novel assessment practices. Yet despite these insights, there remains inadequate systematic proof on the integration of journal writing into Philippine secondary geometry classrooms. Addressing this literature space, the present study probes how journal writing can be used as a pedagogical tool to improve conceptual understanding in geometry, impacting to both localized knowledge and the broader discourse on writing-to-learn strategies in mathematics education.

## MATERIALS AND METHODS

This study employed a quasi-experimental pretest–

posttest non-equivalent groups design. Two intact classes were purposively selected from Grade 10 of Surallah National High School, South Cotabato. Each class consisted of 40 students, with one serving as the experimental group and the other as the control group. Both groups were taught by the same teacher to minimize instructional bias and guarantee consistency in the delivery of lessons.

The research instruments consisted of a 25-item multiple-choice test on selected geometry competencies and an open-ended questionnaire. The test was content-validated by six subject experts and pilot-tested for reliability using the Kuder-Richardson Formula 20 (KR-20), ensuring its appropriateness for measuring student understanding. Meanwhile, the questionnaire was designed to obtain students' perceptions of journal writing as an alternative assessment tool.

The procedure started with the administration of a pretest to both groups to establish baseline performance. The experimental group subsequently engaged in journal writing, where students recorded reflections, solutions, and conceptual insights throughout the intervention. In contrast, the control group was assessed using traditional quizzes and paper-based tests. At the end of the intervention, both groups completed a posttest, while the experimental group was also asked to respond to the open-ended questionnaire to provide qualitative data on their experiences.

For data analysis, descriptive statistics were used to describe performance levels. Paired-sample t-tests compared pretest and posttest scores within groups, while an independent-sample t-test was employed to compare mean gain scores between groups. Responses from the open-ended questionnaire were subjected to thematic analysis to identify emerging themes and patterns in students' perceptions.

In carrying out this study, basic ethical principles were duly observed. Prior to data collection, informed consent was secured from both students and their guardians, to make sure voluntary participation. Anonymity and confidentiality were assured by assigning codes instead of names, and students were also guaranteed that their participation or decision to withdraw at any stage would not affect their academic standing. The study followed to the norm of beneficence by making certain that no harm would result from participation and by providing both groups with equitable learning opportunities throughout the intervention period.

## RESULTS AND DISCUSSION

Data in Table 1 shows the level of students' understanding in selected geometry lessons when exposed to journal writing (experimental) and traditional assessments (control) categorized by group during the pretest and posttest. Likewise, the gain scores and t-test analysis results within and between groups are reflected.

**Table 1:** Results of t-test Analysis of the Students' Level of Understanding in the Pretest and Posttest

Scores/Groups		Control	Experimental	t-stat	p-value
Pretest	Mean	8.48	9.88		
	SD	2.33	2.88		
Posttest	Mean	8.65	12.15		
	SD	2.24	2.62		
t-stat		0.436	4.21		
p-value		0.665	<0.001*		
Gain Scores	Mean	0.18	2.28	3.118	0.002*
	SD	1.66	2.94		

Note. M=Mean, SD=standard deviation. \* $p < .05$ .

### Students' Levels of Understanding

Pretest results indicated that both the experimental group (M = 9.88, SD = 2.88) and the control group (M = 8.48, SD = 2.33) began at the "Beginning" level of understanding. These low scores are expected prior to formal instruction, particularly in subjects widely regarded as difficult. This finding is consistent with Chiphambo and Feza (2020), who noted that students often hold alternative conceptions and misunderstandings in geometry, mainly concerning definitions and applications of terms. Likewise, Jablonski and Ludwig (2023) pointed out that geometry remains one of the most intricate strands of mathematics given the abstract reasoning it requires.

Moreover, posttest results revealed that while both groups remained within the "Beginning" proficiency, the

experimental group (M = 12.15, SD = 2.62) showed a marked improvement compared to the control (M = 8.65, SD = 2.24). The relatively low average scores manifest the broader challenges of teaching and learning geometry, as cited by Martinovic and Manizade (2018), who claimed that difficulties in assessment usually compound students' struggles in acquiring deep conceptual understanding.

These findings support the conclusion that traditional assessments focused heavily on rote recall do not essentially lead to growth in reasoning or higher-order thinking (Campbell *et al.*, 1998). By contrast, alternative assessments like journals may generate space for students to process and reframe knowledge.

### Pretest-Posttest Comparisons

Statistical analysis confirmed that the control group

exhibited no significant difference between pretest and posttest scores,  $t(39) = 0.436$ ,  $p > .05$ , signifying that routine testing failed to move students toward deeper understanding. This lack of progress validates Adams' (1998) warning that conventional assessments in elementary and secondary Mathematics commonly reduce geometry learning to procedural exercises wanting of conceptual grounding.

In contrast, the experimental group validated significant improvement from pretest to posttest,  $t(39) = 4.208$ ,  $p < .05$ . This confirms Yeo and Fan (2003), who established that journal writing in Mathematics classrooms stimulates reflection and allows students to recreate their reasoning processes. Journal entries facilitate students to articulate their thinking and reveal misconceptions for both themselves and their teachers, thereby sustaining Flavell's (1979) metacognitive perspective.

### Comparison of Mean Gain Scores

When mean gain scores were compared, the experimental group ( $M = 2.28$ ) significantly outshined the control group ( $M = 0.18$ ),  $t(78) = 3.118$ ,  $p < .05$ . This finding corroborates Hadzima (2018), who verified how alternative assessments in geometry classes not only improved performance but also endured students' motivation. Also, Jaelani and Hasbi (2022) emphasized that authentic assessments in geometry, such as reflective writing, promoted not only skill acquisition but also deeper comprehension of properties and uses of shapes. Taken together, these results show that journal writing is not merely a recording activity; rather, it works as a cognitive tool that enhances students' internal dialogue with Mathematics. As De Villiers (2012) claimed, geometry learning entails dynamic engagement where reasoning is made explicit; this is a target that journal writing serves effectively.

### Students' Perceptions of Journal Writing

Qualitative analysis revealed three major perceptions: (1) journal writing clarified and deepened students' understanding, (2) it encouraged reflection and refinement of problem-solving processes, and (3) it enhanced memory retention of geometry concepts. These perceptions reaffirm findings by Weldeana and Sbhata (2017), who stated that portfolios and reflective assessments in geometry enhanced understanding across four domains: skills, properties, uses, and representations. Moreover, students' reflections prove what Omar, Shahrill, and Sajali (2018) observed in their work on peer and alternative assessments: students appreciated opportunities to monitor their learning, which in turn improved their grasp of geometry concepts such as angle properties. Journal writing gave learners a sense of ownership of their progress—something traditional tests rarely achieve (Ilany & Shmueli, 1999).

Remarkably, these positive perceptions also harmonize with broader reviews of writing in Mathematics. Powell *et al.* (2017) synthesized evidence that writing tasks whether

journals, proofs, or expository pieces, consistently support deeper mathematical reasoning by forcing students to explain, justify, and connect ideas. McAllister (2013) further demonstrated that written assignments in geometry help students improve proof-writing ability, suggesting that journal writing may scaffold students toward more advanced forms of mathematical communication.

Generally, the results indicate that journal writing is more than an assessment tool; it is also a learning strategy. It addresses the limitations of traditional assessments (Campbell *et al.*, 1998; Adams, 1998) by fostering self-assessment, reflection, and critical thinking (Yeo & Fan, 2003; Hadzima, 2018). The improved performance and positive student perceptions observed in this probe affirm the argument of Jablonski and Ludwig (2023) that reforms in geometry education must include not only new teaching strategies but also more meaningful forms of assessment.

### CONCLUSION

The findings of this study prove that journal writing is an effective alternative assessment strategy that improves students' conceptual understanding of geometry. Compared to traditional paper-and-pencil tests, it offers richer opportunities for reflection, critical thinking, and deeper engagement with mathematical ideas. Although students' proficiency levels remained generally modest, the significant improvement noted in the experimental group stresses the potential of sustained journal writing practices to stimulate higher levels of mastery over time. Afar its measurable effects, journal writing revealed value as a tool for bridging gaps in mathematics assessment practices. By inspiring students to verbalize reasoning and engage in metacognitive reflection, it moves assessment beyond rote evaluation toward approaches that help meaningful learning and conceptual growth. These findings uphold the potential of incorporating reflective writing into mathematics classroom as a pathway to advancing both understanding and long-term retention of concepts.

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