



## A Quasi-Experimental Study on the Effectiveness of Activity Worksheets in Enhancing Grade 9 Learners' Performance in Geometry

Algyr Perez Cabanillas\*<sup>1,2</sup> 

<sup>1</sup>Masapang Integrated National High School, Philippines

<sup>2</sup>Victoria District, Schools Division of Laguna, Philippines

Received : October 5, 2025

Revised : December 5, 2025

Accepted : March 24, 2026

Online : March 31, 2026

### Abstract

This quasi-experimental study examined the effectiveness of activity worksheets in improving the mathematics performance of Grade 9 learners at Masapang Integrated National High School. Fifty students were selected through a match-pairing sampling technique and divided equally into an experimental group and a comparison group. The experimental group utilized teacher-designed activity worksheets, while the comparison group used self-learning modules. Data were gathered using pre-tests, formative assessments, and post-tests and were analyzed through weighted mean, standard deviation, paired-sample and independent-sample t-tests, and Cohen's d to determine effect size. The development and implementation of the activity worksheets were anchored on the ADDIE instructional design model, Tomlinson's instructional materials development framework, and the Instructional Material Development Based on School Curriculum (IMDSC) model. Results revealed that both groups demonstrated low and comparable performance in the pre-test. However, the experimental group showed significantly higher performance in formative and post-test assessments compared to the comparison group, with large effect sizes (Cohen's  $d > 1.0$ ). In contrast, the comparison group showed no statistically significant improvement. The findings indicate that activity worksheets are an effective instructional intervention for enhancing analytical, computational, and problem-solving skills in mathematics. The study recommends the integration of activity worksheets into regular classroom instruction, particularly in modular and distance learning contexts, to support learner engagement and academic achievement.

**Keywords:** *Activity Worksheets, Self-Learning Modules, Mathematics Performance, Grade 9 Learners*

### INTRODUCTION

Mathematics education in the Philippines continues to face significant challenges, particularly in fostering deep conceptual understanding, procedural fluency, and higher-order thinking skills among learners. Numerous national and international assessments consistently show that Filipino students struggle with content mastery, problem-solving, and the application of mathematical concepts to real-world situations. As a result, there is increasing urgency to identify, develop, and implement instructional innovations that can improve student comprehension and performance in mathematics. Traditional approaches to classroom instruction, while familiar and widely used, often fall short in meeting the diverse learning needs present in contemporary classrooms, especially as curricula become more demanding and competency-based.

Mathematics is widely recognized as one of the most challenging subjects in the school curriculum due to its abstract concepts, procedural complexity, and cumulative learning nature. Many students struggle with understanding and applying mathematical principles, often resulting in low performance and diminished confidence in their abilities (Fleming, 2020). The difficulty of mathematics is not merely a reflection of the subject itself but is also influenced by instructional strategies, learning materials, and students' prior knowledge. Research has consistently shown that



students who lack a strong foundation in basic concepts face compounding difficulties as they progress to more advanced topics (Effendi et al., 2018). This challenge is particularly pronounced in the Philippines, where national and international assessments have highlighted significant gaps in mathematics achievement. In the Philippine context, these difficulties are compounded by socioeconomic disparities, limited instructional resources, and curriculum gaps that impede students' development of higher-order reasoning skills. Although mathematics education frameworks emphasize conceptual understanding, procedural fluency, and problem-solving proficiency, many learners fail to develop these competencies due to ineffective instructional materials and inconsistent pedagogical strategies.

The persistent underperformance in mathematics is well documented, notably through the Programme for International Student Assessment (PISA), where the Philippines ranked among the lowest-performing countries. These results highlight systemic challenges that need targeted interventions. Among these challenges are the limited availability of instructional materials designed to support independent learning, insufficient scaffolding for struggling learners, and instructional approaches that are often teacher-centered rather than learner-centered. Classroom observations and research consistently show that many students lack opportunities to explore mathematical ideas at their own pace, engage with contextual tasks, or receive immediate feedback that would help them correct misconceptions.

According to the Program for International Student Assessment (PISA) 2018, Filipino students scored 353 points in mathematics, well below the OECD average of 489 points, placing the country near the bottom in international rankings (Department of Education, 2018). This low performance reflects a need for innovative interventions and instructional strategies that can improve comprehension, problem-solving skills, and learner engagement. Addressing these gaps is essential not only for academic achievement but also for equipping students with critical thinking and analytical skills necessary for real-world applications of mathematics.

Mathematics education requires a careful balance between conceptual understanding, procedural fluency, and problem-solving ability (NCTM, 1989). Problem-solving is central to mathematics, serving as both the content and method of the discipline. Developing problem-solving skills allows learners to connect mathematical concepts to real-life situations, enhancing comprehension and fostering critical thinking. Moreover, in the 21st century, technology and innovative instructional materials, such as activity worksheets, offer new opportunities for learners to actively engage with mathematical content.

Activity worksheets are among the most promising instructional tools that can support this goal. They offer structured and contextualized mathematical activities that allow learners to engage with content actively and independently. Unlike traditional teacher-led instruction, worksheets promote self-paced learning and allow learners to revisit difficult concepts multiple times. Studies have shown that well-designed worksheets promote critical thinking, enhance comprehension, and improve performance by enabling students to apply mathematical concepts to real-world problems (İnan & Erkuş, 2017; Prasadi et al., 2020). Furthermore, activity worksheets provide opportunities for formative assessment, allowing teachers to monitor student progress and adjust instructional strategies accordingly (Black & Wiliam, 1998).

Research has demonstrated the effectiveness of worksheets and instructional modules in improving student outcomes. For example, Lim (2016) found that well-designed modules allowed learners to acquire concepts without the pressure of keeping up with the teacher's pace, promoting independent learning and comprehension. Similarly, Rico (2008) emphasized that post-tests and structured learning materials are critical for evaluating mastery and guiding instructional adjustments. Formative assessments integrated within worksheets provide immediate feedback

and facilitate active learning, supporting the principles of constructivist pedagogy (Black & Wiliam, 1998; Yan et al., 2021).

The effectiveness of instructional interventions is closely tied to the theoretical frameworks guiding their development. The ADDIE model (Analyze, Design, Develop, Implement, Evaluate), Tomlinson's framework for instructional material design, and the Instructional Material Development Based on School Curriculum (IMDSC) model provide structured approaches for creating pedagogically sound learning resources (Watson et al., 2013; Tomlinson, 1998; Syatriana et al., 2013). These frameworks ensure that learning materials are aligned with curriculum objectives, suitable for learners' cognitive levels, and adaptable to diverse learning needs. By incorporating these models, educators can design worksheets that are not only instructional but also engaging, effective, and evidence-based.

Despite extensive research on instructional materials in mathematics, empirical evidence examining quasi-experimental comparisons of activity worksheets and self-learning modules in Grade 9 geometry, particularly in quadrilaterals and similarity, remains limited in the Philippine secondary school context. These topics demand spatial reasoning, proportional thinking, and relational understanding, yet many learners struggle due to insufficient scaffolding and limited formative feedback in modular learning environments.

Existing self-learning modules often emphasize independent reading and procedural practice but provide minimal structured guidance for conceptual development. Thus, a practice gap exists regarding the use of systematically designed, scaffolded activity worksheets as an instructional intervention in geometry.

Accordingly, this study employed a quasi-experimental pre-test–post-test non-equivalent groups design to determine whether learners exposed to activity worksheets demonstrate significantly greater improvement in mathematical performance compared to those using self-learning modules.

## LITERATURE REVIEW

This study was anchored in the ADDIE Model, Jolly & Bolitho's model in Tomlinson (1998), and the Instructional Material Development Based on the School Curriculum (IMDSC). The ADDIE model, a widely recognized instructional design framework, provides five stages: Analyze, Design, Develop, Implement, and Evaluate (Watson et al., 2013). This model guided the researcher in designing effective activity worksheets for Grade 9 mathematics learners. The first step, Analyze, identifies potential performance gaps. Design verifies learning objectives and assessment procedures. Develop focuses on generating and validating instructional resources. Implement engages students in learning, while evaluating measures the quality of instructional outcomes through pre-tests, formative assessments, and post-tests. Instructional design models have long served as foundational frameworks for creating effective learning materials, including worksheets used in mathematics instruction. Recent studies emphasize that ADDIE's cyclical nature allows instructors to continually revise instructional materials to adapt to learner difficulties, thereby improving clarity, pacing, and alignment with curriculum standards (Guido, 2014; Effendi et al., 2018). In mathematics education, such iterative design is crucial, as student misconceptions often stem from incomplete scaffolding or unclear problem structures.

Tomlinson (1998, p. 98) further emphasized instructional material development in five stages: identification, investigation, contextualization, pedagogical realization, and physical production. During identification, teachers and learners assess current teaching-learning phenomena to develop new materials. Investigation involves analyzing problem areas, while contextualization ensures materials incorporate relevant content to strengthen numeracy,

analytical skills, and problem-solving abilities. Pedagogical realization integrates exercises and learning activities, and physical production addresses visual layout and accessibility.

Tomlinson's materials development model (1998) further elaborates on the necessity of contextualization and pedagogical realization when designing instructional tools. It stresses that materials must address learners' prior knowledge, learning styles, and socio-cultural backgrounds. This is particularly relevant in the Philippine educational setting, where classrooms commonly exhibit significant variation in mathematical readiness, language proficiency, and learning pace (Capuno et al., 2019; Villalobos, 2020). Activity worksheets that incorporate contextualized examples, culturally relevant tasks, and scaffolded explanations help bridge these gaps by supporting learners with diverse cognitive profiles.

The IMDSC model builds upon ADDIE, Dick and Carey, and Jolly & Bolitho's models, emphasizing need analysis, design, development, implementation, and evaluation (Syatriana et al., 2013). Teachers must align instructional strategies with performance objectives and employ formative and summative assessments to measure student achievement. This framework ensures that worksheets are not merely supplementary but also pedagogically sound interventions.

A substantial body of literature confirms that activity worksheets serve as an effective intervention for developing mathematical competencies, as they provide structured opportunities for learners to manipulate concepts, test strategies, and receive guided feedback (İnan & Erkuş, 2017; Prasadi et al., 2020). Their effectiveness is largely attributed to key characteristics such as scaffolding of cognitive processes, which enables students to move from basic understanding to higher-order thinking; immediate reinforcement that helps correct misconceptions before progressing to more complex tasks (Black & Wiliam, 1998); and differentiation, which allows worksheets to accommodate learners with varying levels of readiness (Lim, 2016).

Many recent studies emphasize the value of Realistic Mathematics Education (RME), which grounds mathematical concepts in real-world contexts. This approach encourages students to explore mathematical relationships through authentic scenarios, ultimately deepening their conceptual understanding. In RME-aligned worksheets, tasks are not abstract or isolated; instead, they involve real-life problems that help learners connect mathematical principles to everyday experiences. RME-based worksheets have been shown to improve reasoning, engagement, and retention.

Recent studies in Realistic Mathematics Education (RME) consistently show that worksheets embedded with real-life contexts, such as measurement tasks, geometric interpretations, and problem-solving in familiar scenarios, yield significant improvements in reasoning, conceptual understanding, and problem-solving performance (Manggarrani & Marhaeni, 2025; Dinglasan et al., 2023). RME-aligned worksheets promote "guided reinvention," a process in which learners rediscover mathematical concepts through structured problem-solving, enhancing ownership of learning and long-term retention.

Activity worksheets have been proven effective in improving students' mathematical performance, problem-solving skills, and critical thinking (Manggarrani & Marhaeni, 2025; Sari et al., 2022). For example, Manggarrani and Marhaeni (2025) reported that Realistic Mathematics Education (RME)-based worksheets significantly enhanced junior high students' problem-solving abilities and engagement. Similarly, Marpaung et al. (2024) demonstrated that worksheets grounded in authentic contexts improve self-efficacy and mathematical reasoning. These findings align with Effendi et al. (2018), who emphasized the importance of connecting mathematics to students' daily experiences through context-based problems.

Recent studies also highlight the adaptability of worksheets for diverse learning modalities. Baharuddin et al. (2024) showed that RME-based worksheets facilitate blended learning in junior

high schools, supporting both in-person and remote instruction. [Ahmar and Soro \(2023\)](#) found that electronic worksheets significantly enhance reasoning abilities for Grade 8 learners, indicating that digital formats maintain effectiveness while promoting student autonomy.

Moreover, research demonstrates that worksheets improve formative assessment outcomes, enabling teachers to tailor instruction to students' prior knowledge ([Yan et al., 2021](#); [Perry et al., 2021](#)). [Black and Wiliam \(1998\)](#) similarly argue that formative assessment informs teaching adjustments, helping learners achieve learning competencies efficiently. Pre-test and post-test designs, supported by [Rico \(2008\)](#) and [Lim \(2016\)](#), confirm that worksheet-based interventions produce measurable learning gains and reduce performance disparities between learners.

The Realistic Mathematics Education approach, widely applied in worksheet design, emphasizes problem-solving in authentic contexts ([Sari et al., 2022](#); [Manggarrani et al., 2024](#)). This approach enables students to rediscover mathematical concepts and relate them to real-world scenarios, fostering deeper comprehension and engagement. [Dinglasan et al. \(2023\)](#) further support this, finding that RME-oriented worksheets enhance students' conceptual understanding and reflective thinking.

In addition, studies report that worksheets promote higher-order thinking and critical reasoning. [Prasadi et al. \(2020\)](#) showed that STEM-aligned worksheets improved students' critical thinking in geometry tasks, while [Sari et al. \(2022\)](#) found ethnomathematics-based worksheets support cultural relevance and contextual problem-solving. [Umriani et al. \(2020\)](#) similarly highlighted PBL-oriented worksheets' effectiveness in fostering creative thinking.

Taken together, these studies demonstrate that well-designed worksheets, whether RME-based, STEM-oriented, or digitally integrated, serve as highly effective instructional interventions for enhancing mathematical understanding, analytical skills, and self-directed learning. Building on these findings, the present study aims to further strengthen this line of inquiry by evaluating the impact of activity worksheets on Grade 9 learners' performance in quadrilaterals and similarity topics.

The reviewed literature demonstrates that activity worksheets, when grounded in strong theoretical approaches and aligned with curricular goals, can significantly enhance student learning in mathematics. However, empirical studies focusing on Grade 9 learners, specifically in quadrilaterals and similarity, remain limited. This study helps fill that gap by providing evidence-based insights that can inform the development and implementation of worksheet-based interventions in Philippine secondary schools.

The selection of the ADDIE model, Tomlinson's materials development framework, and the IMDSC model is particularly appropriate for Grade 9 geometry instruction. Geometry learning requires carefully sequenced tasks, visual clarity, and progressive scaffolding—features emphasized across all three frameworks. ADDIE ensures systematic alignment between objectives, activities, and assessment; Tomlinson's framework highlights contextualization and pedagogical realization; while IMDSC ensures curriculum alignment within the Philippine basic education system. When applied to geometry topics such as quadrilaterals and similarity, these frameworks support learners' transition from concrete representations to abstract reasoning, addressing common misconceptions documented in secondary mathematics education literature.

The integration of the ADDIE model, Tomlinson's materials development framework, and the IMDSC model provides a complementary instructional foundation for worksheet design in geometry. ADDIE ensures systematic alignment between learning objectives, activities, and assessments; Tomlinson emphasizes contextualization and pedagogical realization; and IMDSC guarantees curriculum coherence within the Philippine K-12 framework. Collectively, these

frameworks support progressive scaffolding, conceptual sequencing, and formative feedback, critical elements in addressing documented misconceptions in quadrilaterals and similarity.

Additionally, Realistic Mathematics Education (RME) principles embedded within the worksheets facilitate “guided reinvention,” enabling learners to construct geometric relationships through contextualized problem-solving rather than rote memorization. This theoretical alignment justifies the expectation of improved conceptual understanding and performance.

## RESEARCH METHOD

This study employed a quasi-experimental research design, specifically the pre-test–post-test non-equivalent groups design, to determine the effectiveness of activity worksheets in enhancing the mathematics performance of Grade 9 learners. Quasi-experimental designs are appropriate in educational settings where random assignment of participants is not feasible, yet systematic comparison between groups is required to evaluate instructional interventions (Stratton, 2019). This design allowed the researcher to examine learning gains within each group and compare performance outcomes between learners exposed to activity worksheets and those who utilized self-learning modules.

The pre-test–post-test approach enabled the measurement of learners’ prior knowledge before the intervention and their achievement after the instructional treatment. By comparing changes in performance across the experimental and comparison groups, the study was able to establish whether observed differences could be attributed to the use of activity worksheets rather than to chance or pre-existing differences.

The participants of the study consisted of fifty (50) Grade 9 learners enrolled at Masapang Integrated National High School during the academic year of the study. The participants were divided into two groups: the Experimental Group ( $n = 25$ ), which used activity worksheets, and the Comparison Group ( $n = 25$ ), which relied on self-learning modules.

The demographic profile of the participants was also considered to provide a clearer description of the study sample. The respondents consisted of Grade 9 learners aged approximately 14 to 16 years old. In terms of gender distribution, both male and female students were represented in the sample. The participants came from similar socio-educational backgrounds, as they were enrolled in the same public secondary school and followed the same curriculum under the K–12 Basic Education Program. These characteristics indicate a relatively homogeneous group, which supports the comparability of the experimental and comparison groups in the study.

A match-pairing sampling technique was employed to minimize variability between groups and enhance internal validity. Learners were paired based on their prior mathematics performance, as reflected in their previous academic records and pre-test scores. Each pair was then assigned to either the experimental or the comparison group. This procedure ensured that both groups were comparable in terms of baseline mathematical ability, thereby strengthening the validity of subsequent comparisons (Yan et al., 2021).

The activity worksheets used in this study were systematically developed using the ADDIE instructional design model, Tomlinson’s instructional materials development framework, and the Instructional Material Development Based on School Curriculum (IMDSC) model (Watson et al., 2013; Tomlinson, 1998; Syatriana et al., 2013). These frameworks guided the design, development, implementation, and evaluation of the instructional materials to ensure alignment with curriculum standards and learner needs.

During the Analysis phase, learners’ performance gaps, common misconceptions, and learning difficulties in quadrilaterals and similarity were identified through diagnostic assessments

and teacher observations. The Design phase focused on formulating clear learning objectives, selecting appropriate assessment strategies, and sequencing learning tasks from simple to complex. In the Development phase, activity worksheets were created incorporating guided examples, contextualized problem-solving tasks, formative assessment questions, and reflective exercises.

The worksheets were grounded in Realistic Mathematics Education (RME) principles, presenting mathematical concepts through real-life and familiar contexts to promote meaningful learning. Each worksheet included activities that encouraged learners to analyze situations, apply geometric relationships, and justify their reasoning. The Implementation phase involved administering the worksheets to the experimental group during regular mathematics instruction, while the Evaluation phase assessed their effectiveness through formative and summative assessments.

To ensure content validity and instructional quality, the activity worksheets were evaluated by mathematics teachers using a teacher validation questionnaire. The instrument assessed the worksheets in terms of content accuracy, appropriateness to learners' level, clarity of instructions, adaptability, usability, and aesthetic value. Feedback from validators was used to revise and refine the worksheets before implementation, consistent with best practices in instructional material development (Baharuddin et al., 2024; Ahmar & Soro, 2023).

Three primary research instruments were used in this study: a pre-test, formative tests, and a post-test. All instruments focused on the topics of quadrilaterals and similarity and were aligned with the Grade 9 mathematics curriculum.

The pre-test was administered to both groups prior to the intervention to assess learners' baseline knowledge and skills. The formative tests were integrated into the instructional process to monitor learners' progress and provide feedback during the intervention. The post-test was administered after the completion of the instructional period to measure learning gains and evaluate the effectiveness of the activity worksheets.

The test instruments consisted of objective and problem-solving items designed to assess conceptual understanding, procedural fluency, and application skills. Content validity was ensured through alignment with curriculum standards and expert review.

Prior to data collection, permission to conduct the study was obtained from school administrators. Ethical considerations were observed, including informing participants of the study's purpose and ensuring confidentiality of their responses. The data collection process followed these steps: (1) Administration of the pre-test to both groups to determine baseline performance. (2) Implementation of the instructional intervention, where the experimental group used activity worksheets and the comparison group used self-learning modules. (3) Administration of formative assessments during the intervention period. (4) Administration of the post-test to both groups after the intervention.

Data were analyzed using appropriate descriptive and inferential statistical techniques. Weighted mean and standard deviation were used to describe learners' performance levels. Paired-sample t-tests were employed to determine significant differences between pre-test and post-test scores within each group. Independent-sample t-tests were used to compare the performance of the experimental and comparison groups.

To determine the practical significance of the intervention, Cohen's *d* was computed to measure effect size. Effect size values were interpreted as small (0.20), medium (0.50), or large (0.80), following standard conventions. Statistical significance was set at the 0.05 and 0.01 levels.

Prior to conducting parametric statistical tests, the assumptions underlying the use of t-tests were examined. Normality of score distributions was assessed using descriptive statistics and visual inspection of score distributions. Given the relatively equal group sizes and the robustness of t-tests to moderate deviations from normality, particularly in educational research contexts, paired-sample and independent-sample t-tests were deemed appropriate. Homogeneity of variances was considered in interpreting independent-sample comparisons. These procedures are consistent with established practices in quasi-experimental educational research.

## FINDINGS AND DISCUSSION

This section presents the results of the study and discusses the findings in relation to existing literature on activity worksheets, formative assessment, and mathematics instruction. The analysis focuses on learners' performance in the pre-test, formative assessments, and post-test, as well as the significant differences observed within and between the experimental and comparison groups.

Table 1 presents the pre-test mean scores of the learners in both the experimental and comparison groups.

**Table 1.** Pre-test mean scores of the students in the comparison group and the experimental group

Group (n = 25)	Mean	Std. Dev.	Descriptive Interpretation
Experimental Group	17.24	6.57	Low
Comparison Group	17.24	6.57	Low

*Legend: 36 – 40 = Very High; 30 – 35 = High; 20 – 29 = Average; 11 – 19 = Low; 1 – 10 = Very Low*

The results indicate that both groups obtained an identical mean score of 17.24, with the same standard deviation of 6.57, interpreted as low performance. This finding suggests that learners in both groups possessed comparable and limited prior knowledge of quadrilaterals and similarity before the intervention. The equivalence of pre-test scores confirms the effectiveness of the match-pairing sampling technique and establishes a valid baseline for comparison.

According to [Berry \(2008\)](#), pre-tests serve as diagnostic tools that provide insight into learners' prior knowledge and misconceptions. In mathematics instruction, such diagnostics are essential for identifying learning gaps and informing instructional planning. The low pre-test performance observed in this study aligns with previous research indicating that geometry topics, particularly those involving spatial reasoning and proportional relationships, pose significant challenges for secondary learners ([Effendi et al., 2018](#); [Dinglasan et al., 2023](#)). These results underscore the need for instructional interventions that provide sufficient scaffolding and contextualized practice.

Table 2 presents the formative mean scores of the students in the comparison group and the experimental group

**Table 2.** Formative test mean scores of the students in the comparison group and the experimental group

Group (n = 25)	Mean	Std. Dev.	Descriptive Interpretation
-------------------	------	-----------	-------------------------------

Experimental Group	116.44	18.15	Average
Comparison Group	97.28	18.10	Average

*Legend: 144 – 160 = Very High; 120 – 143 = High; 80 – 119 = Average; 40 – 79 = Low; 1 – 39 = Very Low*

The experimental group achieved a higher mean score (116.44) compared to the comparison group (97.28), with both groups falling within the average performance range. However, the difference in mean scores reflects a substantial advantage for learners exposed to activity worksheets. The computed effect size (Cohen's  $d = 1.06$ ) indicates a large practical effect, suggesting that the instructional intervention had a meaningful impact on learners' performance during the learning process.

This finding supports the role of formative assessment as an integral component of effective instruction. Black and Wiliam (1998) emphasized that formative assessment improves learning when it provides feedback that helps learners understand their progress and identify areas for improvement. In this study, the activity worksheets embedded formative tasks that guided learners step by step, allowing them to reflect on their understanding and correct misconceptions immediately. In contrast, learners in the comparison group relied primarily on self-learning modules, which offered limited opportunities for guided feedback and interaction.

The results are consistent with Lim (2016) and Perry et al. (2021), who found that structured instructional materials enhance learners' understanding by reducing cognitive overload and supporting gradual concept development. The use of contextualized problems and guided examples in the worksheets likely contributed to learners' improved engagement and comprehension during the formative phase of instruction.

Table 3 presents the post-test mean scores of the students in the comparison group and the experimental group

**Table 3.** Post-test mean scores of the students in the comparison group and experimental group

Group (n = 25)	Mean	Std. Dev.	Descriptive Interpretation
Experimental Group	26.80	5.32	Average
Comparison Group	19.84	7.13	Average

*Legend: 36 – 40 = Very High; 30 – 35 = High; 20 – 29 = Average; 11 – 19 = Low; 1 – 10 = Very Low*

The post-test results reveal that the experimental group outperformed the comparison group, with a mean score of 26.80 compared to 19.84. Although both groups remained within the average performance range, the experimental group demonstrated a markedly higher level of achievement. The computed effect size (Cohen's  $d = 1.11$ ) indicates a large effect, confirming that the use of activity worksheets had a substantial and practical impact on learners' mathematics performance.

These findings align with studies demonstrating the effectiveness of worksheet-based and RME-oriented instruction in improving problem-solving skills and conceptual understanding (Manggarrani & Marhaeni, 2025; Marpaung et al., 2024; Dinglasan et al., 2023). The real-life contexts embedded in the worksheets enabled learners to connect geometric concepts to practical situations, enhancing understanding and retention. By engaging learners in meaningful problem-solving rather than rote procedures, the worksheets supported deeper learning.

Table 4 presents the significant difference between the pre-test and post-test mean scores of the students in each group

**Table 4.** Test of the significant difference between the pre-test and post-test mean scores of the students in each group

Group	Test	Mean	Mean Difference	t-value	Cohen's d
Comparison	Pre-test	17.24	2.60	1.532	---
	Post-test	19.84			
Experimental	Pre-test	17.24	9.56	6.660**	1.29 (Large)
	Post-test	26.80			

*df = 24; \*\*Significant at .01 level; Cohen's d: 0.20 (Small); 0.50 (Medium); 0.80 (Large)*

The experimental group exhibited a statistically significant improvement from pre-test to post-test ( $t = 6.660$ ,  $p < .01$ ), with a large effect size (Cohen's  $d = 1.29$ ). In contrast, the comparison group did not show a statistically significant improvement. This result confirms that the observed learning gains in the experimental group can be attributed to the use of activity worksheets rather than to natural progression or external factors.

This finding reinforces previous research suggesting that worksheets designed with scaffolding, contextualization, and formative feedback promote meaningful learning (Prasadi et al., 2020; Sari et al., 2022). Worksheets enabled learners to engage actively with content, reflect on their understanding, and develop confidence in solving mathematical problems. Umriani et al. (2020) similarly noted that structured worksheets encourage independent exploration and reflective thinking, which are critical for sustained learning gains.

The results of this study highlight several important pedagogical implications. First, activity worksheets can serve as effective instructional tools for differentiating instruction in heterogeneous classrooms. By providing guided tasks and contextualized problems, worksheets accommodate learners with varying levels of prior knowledge and learning pace. Second, the integration of formative assessment within worksheets enables teachers to monitor learning progression and provide timely feedback, enhancing instructional responsiveness.

Furthermore, the findings suggest that activity worksheets are particularly beneficial in modular and independent learning contexts, where direct teacher support may be limited. As Philippine schools continue to adopt flexible learning modalities, worksheets offer a practical and scalable solution for supporting learner engagement and comprehension. These results align with global trends emphasizing learner-centered instruction and the use of structured materials to improve mathematics outcomes (Effendi et al., 2018; OECD, 2018).

The substantial improvement observed in the experimental group can be explained by the instructional features embedded in the activity worksheets. The worksheets provided structured scaffolding, allowing learners to gradually progress from guided examples to independent problem-solving. This design aligns with constructivist learning principles, where learners actively construct understanding through engagement and reflection. The integration of contextualized tasks further supported conceptual understanding by enabling learners to relate geometric concepts to familiar situations, consistent with Realistic Mathematics Education principles.

In contrast, the self-learning modules used by the comparison group offered limited opportunities for guided feedback and adaptive scaffolding. Without structured formative support,

learners may have struggled to identify and correct misconceptions, which likely constrained learning gains. These findings reinforce previous studies demonstrating that instructional materials emphasizing active engagement, contextualization, and formative feedback produce stronger learning outcomes than materials relying primarily on independent reading and practice.

## **CONCLUSIONS**

This study examined the effectiveness of activity worksheets in enhancing the mathematics performance of Grade 9 learners from a single public secondary school in the topics of quadrilaterals and similarity. Using a quasi-experimental design, the study provides evidence that activity worksheets, when systematically designed and implemented, can significantly improve learners' geometry performance compared to self-learning modules.

The results revealed that both the experimental and comparison groups demonstrated low levels of prior knowledge before the intervention, as reflected in their pre-test scores. However, learners exposed to activity worksheets exhibited statistically significant and practically meaningful learning gains, as evidenced by higher formative and post-test scores and large effect sizes. In contrast, the comparison group showed only minimal improvement, which was not statistically significant. These findings indicate that activity worksheets, when systematically designed and implemented, contribute substantially to learners' academic achievement in mathematics.

The effectiveness of activity worksheets may be attributed to several pedagogical features. First, the worksheets provided structured scaffolding that guided learners from basic concepts to more complex applications, reducing cognitive overload and supporting gradual knowledge construction. Second, the integration of contextualized and real-life problem situations enhanced learners' engagement and facilitated meaningful connections between mathematical concepts and everyday experiences. Third, the inclusion of formative assessment tasks enabled learners to receive immediate feedback and reflect on their understanding, promoting self-regulated learning.

From a practical standpoint, the findings underscore the value of activity worksheets as cost-effective and adaptable instructional materials, particularly in contexts where teacher-learner interaction may be limited. In the Philippine basic education setting, where modular and flexible learning modalities remain prevalent, activity worksheets offer a viable means of enhancing instructional quality and learner outcomes. The study contributes to the growing body of literature supporting learner-centered instructional strategies and provides evidence-based guidance for mathematics teachers seeking to improve geometry instruction.

While the findings demonstrate strong instructional benefits within the study context, conclusions should be interpreted within the scope of the sample, grade level, and subject area investigated. The results support the integration of activity worksheets as a learner-centered instructional strategy for Grade 9 geometry, particularly in modular and independent learning settings. Future implementations and generalizations should consider variations in school context, learner characteristics, and instructional delivery.

## **LIMITATION & FURTHER RESEARCH**

Despite the significant findings of this study, several limitations must be acknowledged. First, the study involved a relatively small sample drawn from a single public secondary school. Although the use of match-pairing enhanced internal comparability between groups, the limited sample size and single-school context may constrain the generalizability of the findings. Future research should involve larger and more diverse samples across multiple schools or districts to strengthen external validity and enable broader educational inferences.

Second, the intervention was implemented only within the instructional period allocated for the topics of quadrilaterals and similarity. As a result, the findings primarily reflect short-term learning gains. Longer implementation periods or longitudinal research designs are recommended to examine the sustained effects of activity worksheets on learners' retention, transfer of learning, and higher-order thinking skills in mathematics.

Third, this study focused exclusively on learners' academic performance as measured through test scores. Other important learner-related variables, such as attitudes toward mathematics, motivation, self-efficacy, and engagement, were not examined. Future studies may adopt mixed-methods approaches that combine quantitative achievement measures with qualitative data (e.g., interviews, reflective journals, or surveys) to provide a more comprehensive understanding of both cognitive and affective outcomes associated with worksheet-based instruction.

In addition, the study did not explicitly investigate the role of teacher facilitation during the implementation of activity worksheets. Differences in instructional delivery, feedback practices, and classroom management strategies may influence the effectiveness of worksheet-based interventions. Future research may examine how teacher mediation interacts with worksheet design to optimize learning outcomes and instructional effectiveness.

Finally, future studies may explore the use of activity worksheets across other mathematics topics, grade levels, and learning modalities. In particular, examining the integration of digital or interactive worksheets within technology-enhanced learning environments may provide valuable insights into the scalability, adaptability, and long-term instructional value of worksheet-based interventions in diverse educational contexts.

## REFERENCES

- Ahmar, S., & Soro, S. (2023). *The effect of using electronic student worksheets in mathematics learning on the reasoning ability of 8th-grade junior high school students*. *Edumatica: Jurnal Pendidikan Matematika*, 13(2), 114–125. <https://doi.org/10.22437/edumatica.v13i02.26352>
- Aksan, J. A. (2021). Effect of modular distance learning approach to academic performance in mathematics of students in Mindanao State University–Sulu senior high school amidst COVID-19 pandemic. *Open Access Indonesia Journal of Social Sciences*, 4(4), 386–409. <https://doi.org/10.37275/oaijss.v4i2.64>
- Ambayon, E. E. (2020). Modular-based approach and students' achievement in literature. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.3723644>
- Baharuddin, S., Sari, N. H., Abrar, A. I. P., Nur, F., & Angriani, A. D. (2024). Development of student worksheets with a realistic mathematics education approach: Set material for junior high school class VII. *MaPan: Jurnal Matematika dan Pembelajaran*, 12(1). <https://journal.uin-alauddin.ac.id/index.php/Mapan/article/view/46992>
- Berry, R. Q. (2008). Access to upper-level mathematics: The stories of successful African American middle school boys. *Journal of Research in Mathematics Education*, 39(5), 464–488.
- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74. <https://doi.org/10.1080/0969595980050102>
- Capuno, R. G., Necesario, R. T., Etcuban, J. O., Espina, R. C., Padillo, G. G., & Manguilimotan, R. P. (2019). Attitudes, study habits, and academic performance of junior high school students in mathematics. *International Electronic Journal of Mathematics Education*, 14(3), 547–561. <https://doi.org/10.29333/iejme/5768>
- Columbano, M. (2019). Development and validation of modules in basic mathematics to enhance

- students' mathematics performance. *International Journal of Innovative Technology and Exploring Engineering*, 8(12), 4203–4207. <https://doi.org/10.35940/ijitee.L2684.1081219>
- Department of Education. (2018). *K to 12 curriculum guide: Mathematics*. Department of Education, Republic of the Philippines.
- Dinglasan, J. K. L., Caraan, D. R. C., & Ching, D. A. (2023). Effectiveness of realistic mathematics education approach on problem-solving skills of students. *International Journal of Educational Management and Development Studies*, 4(2).
- Effendi, K. N. S., Putra, Z. H., & Witri, G. (2018). The development of mathematics student worksheet for school literacy movement. *Journal of Physics: Conference Series*, 1088(1), Article 012033. <https://doi.org/10.1088/1742-6596/1088/1/012033>
- Fleming, J. (2020). The challenges of learning mathematics: Cognitive and instructional perspectives. *International Journal of STEM Education*, 7, Article 45. <https://doi.org/10.1186/s40594-020-00234-6>
- Guido, R. M. D. (2014). Evaluation of a modular teaching approach in materials science and engineering. *American Journal of Educational Research*, 2(11), 1126–1130. <https://doi.org/10.12691/education-2-11-20>
- Guinocor, M. M., Rillo, R. M., & Pasion, R. A. (2020). Mathematics performance of students in a Philippine state university. *International Electronic Journal of Mathematics Education*, 15(3), Article em0586. <https://doi.org/10.29333/iejme/7859>
- İnan, C., & Erkuş, S. (2017). The effect of mathematical worksheets based on multiple intelligences theory on the academic achievement of students in the fourth grade primary school. *Universal Journal of Educational Research*, 5(8), 1372–1377. <https://doi.org/10.13189/ujer.2017.050810>
- Khashi'ie, N. S., Abu, M. S., & Yusof, Y. M. (2017). A comparison study of students' performance in pre- and post-result of a mathematics competency test. *MATEC Web of Conferences*, 87, Article 04001. <https://doi.org/10.1051/matecconf/20178704001>
- Lim, T. (2016). Effectiveness of instructional modules in mathematics classrooms. *Asian Journal of Educational Research*, 4(2), 23–34.
- Marpaung, I. A. A., Arnita, & Fauzi, K. M. A. (2024). Development of student worksheets based on a realistic mathematics learning approach to improve problem-solving ability and self-efficacy. In *Proceedings of the 5th International Conference on Science and Technology Applications (ICOSTA 2023)*. <https://doi.org/10.4108/eai.2-11-2023.2343263>
- Manggarrani, A., & Marhaeni, N. H. (2025). The effectiveness of using realistic mathematics education (RME)-based students' worksheet to improve students' mathematical problem-solving skills. *EduMatSains: Jurnal Pendidikan, Matematika dan Sains*, 9(2), 316–325. <https://ejournal.uki.ac.id/index.php/edumatsains/article/view/5973>
- Manggarrani, A., Marhaeni, N. H., & Triyono, A. (2024). Design of realistic mathematics education-based student worksheets to improve students' mathematical problem-solving skills. *EDUTREND: Journal of Emerging Issues and Trends in Education*, 1(2), 121–128. <https://rcsdevelopment.org/index.php/edutrend/article/view/340>
- Munifah, M., Suyitno, H., & Dwidayati, N. (2019). Management development of student worksheets to improve teacher communication skills: A case study of self-efficacy and student achievement. *Journal for the Education of Gifted Young Scientists*, 7(4), 777–798. <https://doi.org/10.17478/jegys.625618>
- Napiza, A. D. (2018). *Activity sheets for the improvement of problem solving* (Unpublished master's thesis). Laguna State Polytechnic University, Philippines.
- National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for*

- school mathematics*. National Council of Teachers of Mathematics.
- Organisation for Economic Co-operation and Development. (2018). *Education at a glance 2018: OECD indicators*. OECD Publishing. <https://doi.org/10.1787/eag-2018-en>
- Perry, T., Davies, P., & Qureshi, F. (2021). The impact of formative assessment on student learning outcomes. *Assessment in Education: Principles, Policy & Practice*, 28(2), 123–140.
- Peteros, R. E., Columna, D. G., & Etcuban, J. O. (2020). Factors affecting mathematics performance of junior high school students. *International Electronic Journal of Mathematics Education*, 15(1), Article em0556. <https://doi.org/10.29333/iejme/5938>
- Prasadi, A. H., Wiyanto, W., & Suharini, E. (2020). The implementation of student worksheet based on STEM and local wisdom to improve critical thinking ability of fourth grade students. *Journal of Primary Education*, 9(3), 227–237. <https://doi.org/10.15294/jpe.v9i3.37712>
- Rico, M. (2008). *Measuring learning outcomes using post-tests in mathematics* (Unpublished manuscript). University of the Philippines.
- Sari, N., Salafudin, S., Sholehuddin, M. S., & Sholikhah, A. (2022). Development of mathematics realistic education worksheet based on ethnomathematics in elementary school. *Phenomenon: Jurnal Pendidikan MIPA*, 12(1), 77–89. <https://journal.walisongo.ac.id/index.php/Phenomenon/article/view/10853>
- Segumpan, A. M., & Tan, C. S. (2018). Mathematics performance and anxiety of junior high school students in a flipped classroom. *European Journal of Education Studies*, 2(1), 1–33. <https://doi.org/10.5281/zenodo.1325918>
- Stratton, S. J. (2019). Quasi-experimental design (pre-test and post-test studies) in prehospital and disaster research. *Prehospital and Disaster Medicine*, 34(6), 573–574. <https://doi.org/10.1017/S1049023X19005053>
- Syatriana, E., Husain, D., Haryanto, H., & Jabu, B. (2013). A model of creating instructional materials based on the school curriculum for Indonesian secondary schools. *Journal of Education and Practice*, 4(20). <https://www.iiste.org/Journals/index.php/JEP/article/view/7893>
- Tomlinson, B. (1998). *Materials development in language teaching*. Cambridge University Press.
- Umriani, U., Suyitno, H., & Dwidayati, N. (2020). Analysis and design of mathematics student worksheets based on PBL learning models to improve creative thinking. *International Journal of Advanced Science and Technology*, 29(7s), 226–237.
- Villalobos, R. (2020). Issues affecting the academic performance in mathematics of senior high school students at selected schools in Zambales: Basis for the support of university administration department. *SSRN Electronic Journal*. <https://ssrn.com/abstract=3652954>
- Watson, R., Ampa, A. T., & Syatriana, E. (2013). *Instructional material development based on the school curriculum* (Unpublished manuscript).
- Yan, Z., King, R. B., & Haw, J. Y. (2021a). Formative assessment, growth mindset, and achievement: Examining their relations in the East and the West. *Assessment in Education: Principles, Policy & Practice*, 28(3), 228–260. <https://doi.org/10.1080/0969594X.2021.1988510>
- Yan, Z., King, R. B., & Haw, J. Y. (2021b). A systematic review on factors influencing teachers' intentions and implementations regarding formative assessment. *Assessment in Education: Principles, Policy & Practice*, 28(3), 228–260. <https://doi.org/10.1080/0969594X.2021.1884042>