



Integrated Language Strategies for Teaching Sets to Grade 7 Learners in a Philippine Public School: A One-Group Pretest-Posttest Study

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ABSTRACT

Purpose of the study: This study examined whether language strategies improve Grade 7 learners' conceptual understanding of sets. It also explored how the learners perceived the use of these strategies in learning mathematics.

Methodology: A one-group pre-test–post-test design was conducted with 27 low-performing Grade 7 learners from a public school in North Cotabato. The intervention used vocabulary building, composing with keywords, metacognitive prompts, defining formats for mathematical clarity, and a profile-and-frame approach in lessons on sets, subsets, union, and intersection. Quantitative data came from a researcher-made 40-item test, while qualitative data on learner perceptions were gathered through guided interviews.

Main Findings: Learners' mean scores increased from 12.93 (pre-test) to 20.04 (post-test), and the Wilcoxon Signed Rank Test indicated a statistically significant improvement in conceptual understanding ($p = .001$). Thematic analysis showed that language strategies supported clarity, retention, and engagement, though some learners experienced cognitive overload and language-related difficulties.

Novelty/Originality of this study: This study demonstrates how the use of specific language strategies in teaching sets can enhance conceptual understanding of low-performing group of Grade 7 students. It also highlights the need to manage cognitive load and language demands, underscoring the importance of differentiated support when using language-rich approaches in mathematics instruction.

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1. INTRODUCTION

Mathematics is central to logical reasoning, problem solving, and further learning in the sciences, yet many students still experience it as difficult because of conceptual demands, prior negative experiences, and classroom factors [1]-[4]. Within the junior high school curriculum, set theory is a foundational topic because it introduces learners to classification, relations, notation, and logical structure that later support work in algebra, probability, and other mathematical domains [5].

Despite this foundational role, set theory is commonly reported as difficult for students. Learners often confuse elements and subsets, rely on intuitive everyday notions of collections, and struggle to interpret formal notation, definitions, and logical relations [6]-[10]. These difficulties are not only conceptual; they are also linguistic because understanding sets requires learners to coordinate ordinary words, technical vocabulary, symbolic notation, and compact written explanations.

Research in mathematics education has consistently shown that language is not merely a vehicle for reporting mathematical ideas but also a medium for constructing them [11]-[14]. Explicit attention to vocabulary, explanation, and discourse helps learners access mathematical meanings, especially when concepts are abstract and densely packed with technical terms [15]-[17]. Recent reviews and multilingual mathematics studies likewise emphasize that language-responsive instruction can improve participation, reasoning, and conceptual understanding when teachers intentionally connect words, symbols, examples, and classroom talk [18]-[21].

However, much of the recent empirical work on language-responsive mathematics instruction has focused on fractions, percentages, probability, multilingual classroom discourse, or broad theoretical frameworks rather than on junior high school set theory as a specific content area [18], [21]-[27]. Studies on set theory, meanwhile, have largely documented learning obstacles and misconceptions rather than examining classroom interventions that integrate language strategies to address those obstacles [6]-[9]. As a result, there remains limited empirical evidence on how an integrated set of language strategies can support low-performing junior high school learners in understanding sets, subsets, union, and intersection.

The present study addresses this gap in three ways. First, it examines an integrated language-strategy intervention that combines vocabulary building, composing with keywords, metacognitive prompts, defining formats, and profile-and-frame activities rather than testing a single technique in isolation [16], [22], [28]-[30]. Second, it focuses on set theory, a topic where the precision of language and the coordination of symbols and meanings are especially important [6]-[10], [25]. Third, it reports evidence from a Philippine public school remediation context involving low-performing Grade 7 learners, a context that remains underrepresented in the international literature on language-responsive mathematics instruction [20], [21], [24].

The study is anchored in Vygotsky's view that learning is socially mediated and supported through scaffolding [31] and in Cognitive Load Theory, which suggests that instruction can improve learning by reducing unnecessary processing demands and by structuring attention toward essential relationships [32], [33]. In the context of set theory, language strategies may help learners by clarifying terms, making relations explicit, and providing sentence and representation frames that support explanation and recall.

In view of the identified gap, the study aimed to:

- 1) describe learners' conceptual understanding of set theory topics before and after the use of integrated language strategies;
- 2) determine whether there was a significant difference between pretest and posttest scores; and
- 3) examine learners' perceptions of the use of language strategies in learning set theory.

2. RESEARCH METHOD

2.1. Research Design

This study employed a quantitative research design with qualitative support. Quantitative data were obtained using a one-group pre-test–post-test pre-experimental design, while the qualitative strand used semi-structured interviews to enrich interpretation of the learning outcomes [34]-[37]. This design was appropriate because the study was conducted as a classroom-based remediation activity for an intact group of learners for whom withholding the intervention was impractical.

2.2. Research Subjects

A single group of low-performing Grade 7 learners, composed of 17 females and 10 males enrolled from a public school in the Schools Division of the Province of North Cotabato in the 2nd quarter of S.Y. 2024-2025, participated in the study. The study employed a purposive sampling technique since the intervention was designed for low-performing group of students.

2.3. Data Collection Instruments and Intervention

Table 1 summarizes the instruments and materials used in the study.

Table 1. Summary of instruments and materials used in the study

Instrument/Material	Description	Purpose
Conceptual understanding test (Pre-test and Post-test)	Researcher-made 40-item multiple-choice test on sets, subsets, union, and intersection. The original 60-item pool was pilot-tested, and only acceptable items were retained. One point was awarded for each correct response.	To measure learners' conceptual understanding before and after the intervention.
Semi-structured interview guide	Guide questions focusing on clarity, usefulness, difficulty, and overall experience with the language strategies.	To gather learners' perceptions of the intervention.
Language-strategy lesson package	Two-week remedial lesson package integrating vocabulary building, composing with keywords, metacognitive prompts, defining formats, profile-and-frame activities, guided examples, and visual representations.	To implement the classroom intervention on set theory topics.

The instruments that were used in this study are described below:

2.3.1 Conceptual understanding test (Pre-Test and Post-Test)

This is a 40-item multiple choice test designed to assess the conceptual understanding of the Grade 7 learners in the content based on the competencies in the Math curriculum for Grade 7 which covers the topics on sets and subsets, union and intersection of sets. The test scores for this will be one (1) point for each correct answer. Originally, the test was composed of 60 items. It was pilot-tested, and only those acceptable items were included in the pre-test and post-test.

2.3.2 Semi-Structured Interview Guide

This is a set of semi-structured interview guide questions that was used during the interview, designed to gather information about the learners' perceptions of the use of language strategies in teaching the topics in sets.

2.3.3 Language-strategy lesson package

Two-week remedial lesson package integrating vocabulary building, composing with keywords, metacognitive prompts, defining formats, profile-and-frame activities, guided examples, and visual representations.

2.3.4 Intervention

The intervention consisted of teaching sets, subsets, union, and intersection of sets using different language strategies integrated in the lesson delivery. The intervention lasted for two weeks and served as a remediation program on sets, subsets, union, and intersection. Each lesson integrated explicit vocabulary work, structured sentence support, guided questioning, and visual organizers. Vocabulary building and composing with keywords supported precise use of mathematical terms [12], [16], [17]; metacognitive prompts supported guided explanation and checking for understanding [28]; defining formats and profile-and-frame activities scaffolded comparison, classification, and written explanation [22], [27], [29], [30].

2.4. Data Analysis Techniques

After collecting the data, descriptive statistics (mean, standard deviation) were computed to describe learners' levels of conceptual understanding of the topics. The Wilcoxon Signed Rank Test was employed to determine whether the observed differences between pre-test and post-test scores were statistically significant, given the small sample size and non-normal distribution often found in intact classes. This quantitative analysis provided evidence regarding the effectiveness of the language strategies in improving learners' conceptual understanding.

Furthermore, learners were interviewed about their experiences with the language strategies used in the intervention. Interview questions focused on the perceived clarity, usefulness, and effectiveness of each strategy. Responses were audio-recorded, transcribed, and analyzed thematically to identify recurring patterns and insights about learners' perceptions.

2.5. Research Procedures

Before the conduct of the study, permission was sought from the school principal to conduct the research. Consent forms were distributed to the learners' parents or guardians, explaining the purpose, procedures, and objectives of the study. Participants were informed that their participation was voluntary, and they had the right to withdraw at any stage of the research without penalty. Upon signing the informed consent, all data collected, including pre-test and post-test scores and interview responses, were then tabulated, computed, and analyzed. Figure 1 summarizes the procedure.

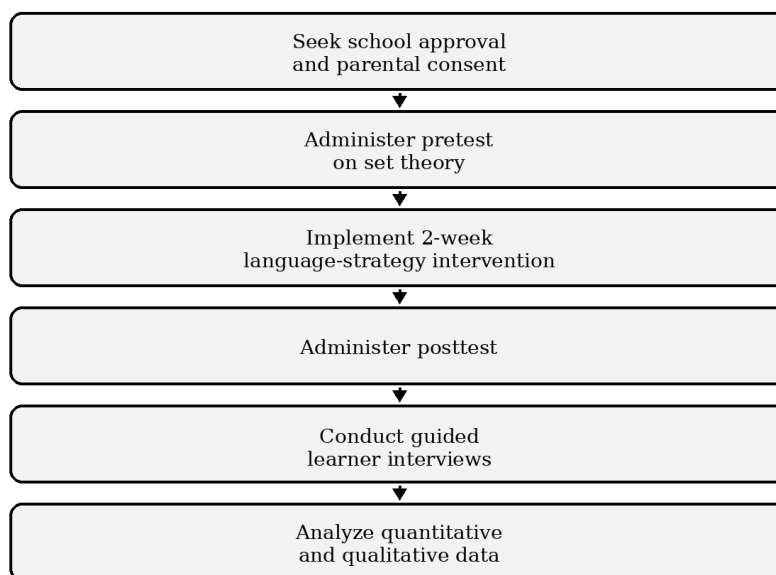


Figure 1. Research Procedure

3. RESULTS AND DISCUSSION

This section presents the results and discussion of the study.

3.1. Learners' Conceptual Understanding of Topics in Set Before and After Using Language Strategies in Teaching

Table 2. Mean Scores of the Grade 7 Learners before and after intervention

Phase	N	Mean Score	Standard Deviation	Level
Before Intervention (Pretest)	27	12.93	4.70	Beginning
After Intervention (Post test)	27	20.04	7.64	Beginning

Note: The proficiency labels follow the Department of Education-approved K–12 curriculum grading scheme. Beginning (0-29) indicates minimal and fragmented understanding and a need for substantial teacher support; Developing (30-31) indicates partial but inconsistent understanding;

Approaching Proficient (32-33) indicates mostly correct but still incomplete understanding; Proficient (34-35) indicates solid understanding; and Advanced (36-40) indicates comprehensive and flexible understanding.

Table 2 shows that learners' mean score increased from 12.93 (SD = 4.70) in the pretest to 20.04 (SD = 7.64) in the posttest, indicating an average gain of 7.11 points. Although both mean scores remained within the Beginning level, the higher posttest mean suggests that learners moved from a more fragmented understanding of set theory toward a more connected grasp of elements, subsets, union, and intersection. This pattern suggests that the integrated language strategies helped learners attach clearer meanings to technical terms and relate symbols to verbal explanations and visual representations. The finding is consistent with studies showing that explicit attention to mathematical vocabulary and structured classroom discourse supports conceptual understanding, especially when the topic is abstract and language-dense [12], [13], [16], [18]. At the same time, the posttest mean remaining at the Beginning level indicates that short-term language support alone was not enough to produce mastery, which is understandable given that misconceptions in set theory are often persistent and closely tied to the precise use of definitions and logical relations [6]-[10].

3.2. Test of Difference on the Learners' Conceptual Understanding Before and After Using Language Strategies in Teaching

Table 3. Test of Difference on Learner's Pre-test and Post-test Scores using Wilcoxon Signed Rank Test

		N	Mean Ranks	Sum of Ranks	Z	P
Pretest – Posttest	Negative Ranks	3	5.50	16.50	-3.932	.001
	Positive Ranks	22	14.02	308.50		
	Ties	2				
	Total	27				

Table 3 shows the results of the Wilcoxon Signed-Rank Test. The Wilcoxon signed-rank test further strengthens this interpretation. With 22 positive ranks, 3 negative ranks, and 2 ties, the posttest scores were significantly higher than the pretest scores ($Z = -3.932$, $p = .001$). This result indicates that the observed improvement was unlikely to be due to chance and supports the view that the integrated language strategies contributed to better conceptual understanding. A plausible explanation is that vocabulary building, composing with keywords, metacognitive prompts, and defining formats reduced ambiguity and guided learners to verbalize relationships among mathematical ideas. This interpretation aligns with Vygotsky's view of learning as scaffolded and socially mediated [31] and with Cognitive Load Theory [32]-[33], which suggests that structured support can reduce unnecessary processing demands and direct attention to essential relationships. However, the larger posttest standard deviation also indicates that the intervention did not benefit all learners equally, suggesting that differences in prior knowledge, language proficiency, and readiness may have shaped how much support each learner was able to use [23], [24], [29], [30].

3.3. Perceptions of the Grade 7 Learners of Using Language Strategies in Teaching Topics in Sets

The perceptions of the learners on the use of language strategies are shown in Table 4.

Table 4. Themes on the Perceptions of the Grade 7 learners of using language strategies in teaching topics in Set theory.

Themes	Description	Sample Transcript
Clarity	Students perceive language strategies as tools that improve their understanding by using simple words.	" <i>Madali maintindihan kasi simple lang ang mga words... at inuulit-ulit pa yung mga clue, ... yung keywords.</i> " [It's easy to understand because the words are simple... and the clues are repeated,... like the keywords.]
		" <i>Simple lang kasi yung mga words na ginagamit, tapos hindi siya mahaba. Madali lang siya matandaan kaya pag sinabi yung word, makuha ko na yung sagot.</i> " [The words used are simple, and it's not long. It's easy to remember, so when the word is mentioned, I can already get the answer.]
Retention	Students believe that language strategies, such as repetition of keywords, examples, improve their ability to remember concepts in set theory	" <i>Nung may mga keywords na at yung nagsagot kami ng... ano... yung identify yung ilan ang laman ng set, maalala ko na talaga yung cardinality.</i> " [When I had the keywords and we answered..when I identified how many elements are in the set, I was really able to remember cardinality.]
		" <i>Yung union at intersection ng sets, makalito pa talaga, pero nung parati na ginacconnect sa kanya yung mga keywords, mas maintindihan ko at maalala ko na.</i> " [Union and intersection of sets were still confusing, but

		when the keywords were consistently connected to them, I was able to understand and remember better.]
		<i>"Makahelp talaga siya na madali mo maalala yung lessons."</i> [It really helped me remember the lessons easily.]
		<i>"Para sa akin, effective talaga kasi maalala ko yung ibig sabihin ng word kapag binigay yung mga keywords."</i> [For me, it's really effective because I can remember the meaning of the word when the keywords are given.]
Engagement	Language strategies such as involving keywords, examples, relatable analogies, asking questions make learning set theory more engaging.	<i>"Pag nagtatanong yung teacher, naeencourage kang magsagot kasi yung mga tanong is... tinutulungan ka talagang mag-isip ng sa'yo lang."</i> [When the teacher asks questions, I'm encouraged to answer because the questions... really help me think on my own.]
		<i>"Maganda yung strategy kasi nakakapag-share din kami ng nasa isip namin tapos makagawa kami ng sentences gamit yung mga keywords lang na binigay."</i> [The strategy is good because we were able to share what we were thinking, and then we could create sentences using only the keywords that were given.]
Cognitive Overloaded	Students feel overwhelmed when too many new terms are introduced at once.	"Medyo minsan nakakalito kasi madami masyadong words." [Sometimes it's a bit confusing because there are too many words]
Language Barrier	Students face difficulty in understanding and applying the strategies due to challenges with the English language, particularly in constructing sentences or comprehending mathematical terms in English.	<i>"Minsan nahihirapan talaga ako lalo na dun sa paggawa ng mga sentences kasi English... hindi ako magaling mag-English."</i> [Sometimes I really struggle, especially with making sentences because it's English... I'm not good at English.]
		<i>"Nahirapan ako lalo na dun sa paggawa ng sentence kasi English... pero nakatulong din sa spelling ko."</i> [I struggled especially with making sentences because it's English... but it also helped with my spelling.]
Practicality	Students find language strategies most effective when paired with visual aids and practice exercised	<i>"Mas nagets ko yung mga concepts nung pinasulat kami ng sentence about subset and intersection na gamit yung mga keywords at categories na binigay."</i> [I understood the concepts better when we were asked to write sentences about subset and intersection using the keywords and categories that were given]
		<i>"mas naintindihan ko yung concepts nung nagbigay ng keywords tapos gidrawing pa sa board, mas nakakatulong talaga pag meron pa yung drawing."</i> [I understood the concepts better when keywords were given and then also drawn on the board; it really helps more when there's a drawing too.]

The qualitative findings explain how the strategies influenced learning. Learners described the lessons as clearer, easier to remember, and more engaging when teachers used simple wording, repeated keywords, guided questions, and sentence-building activities. These responses suggest that the intervention did more than improve test performance; it also made abstract mathematical ideas more discussable and more memorable. This supports the view that language in mathematics is not only a medium for communicating ideas but also a tool for constructing meaning [11]-[14]. The finding is also in line with studies on language-responsive mathematics classrooms showing that learning improves when teachers deliberately connect words, symbols, examples, and classroom talk [18], [20], [22].

At the same time, the themes of cognitive overload and language barrier clarify why the gains, although significant, were still limited. Some learners found the lessons difficult when too many new terms were introduced at once or when they had to explain ideas in English. This indicates that language strategies are most effective when they are paced carefully, differentiated, and matched to learners' current language resources. In other words, language support can facilitate conceptual understanding, but it can also become an added burden when the linguistic demand

exceeds what learners can process in a short period. This result is consistent with earlier research suggesting that language-rich mathematics instruction should be sequenced carefully and supported by scaffolds rather than overloaded with too many new terms at once [13], [24], [29], [30].

Another important qualitative result is the theme of practicality. Learners reported that the strategies became more useful when they were paired with drawings, board work, and guided examples. This is pedagogically important because set theory requires learners to coordinate definitions with symbolic and visual representations. The finding suggests that language strategies should not be implemented in isolation; they work best when combined with visual and multimodal support. This interpretation is consistent with multimedia learning principles [38], [26] and with studies showing that visual support helps learners in multilingual or language-sensitive mathematics classrooms connect verbal and symbolic meanings more effectively [39], [40].

Overall, both the quantitative and qualitative findings suggest that integrated language strategies can improve conceptual understanding of set theory by making technical vocabulary, symbolic notation, and conceptual relationships more explicit and discussable. In relation to the international literature, the study contributes evidence from an underrepresented remediation context in a Philippine public school and shows that even a short intervention can support initial conceptual understanding among low-performing learners. Thus, for abstract junior high school mathematics topics, language strategies are most beneficial when they are explicit, multimodal, sequenced, and dialogic, so that vocabulary, representations, and conceptual relations are taught together rather than as separate parts of instruction.

4. CONCLUSION

The use of language strategies led to meaningful gains in learners' conceptual understanding of set theory, as indicated by higher post-test mean scores and a statistically significant pretest–posttest difference. At the same time, the wide variability in post-test performance and qualitative accounts of cognitive overload and language-related difficulties show that not all learners benefited equally and that additional, differentiated support is still needed. This study was limited by its focus on a specific set of language strategies, a single mathematical topic (sets) within the K to 12 curriculum, and a relatively short intervention duration, which restricts the generalizability of the findings and does not capture long-term effects. Reliance on self-reported perceptions and the lack of control over individual factors such as language proficiency and prior mathematical knowledge may also have influenced the results. Additionally, the research is limited to Grade 7 learners, as they are typically introduced to foundational set theory concepts at this educational level. The study is confined to a single school or classroom, which allows for in-depth observation but limits the generalizability of the findings across different educational contexts. Despite these constraints, the findings offer useful evidence that carefully designed language strategies can support students' understanding of challenging mathematical concepts and point to promising directions for future classroom-based interventions in other topics and grade levels.

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