

Effectiveness of the ARAL Numeracy Program in Improving the Mathematical Problem-Solving Skills of Grade 3 Pupils

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Abstract

Developing foundational reading and numeracy skills during kindergarten is essential to children's readiness for subsequent learning. This study examined intervention strategies used to develop early reading and numeracy skills among kindergarten pupils, focusing on their extent of implementation, perceived effectiveness, and implementation challenges. A descriptive quantitative design was employed, with kindergarten teachers in Ambaguio District, Nueva Vizcaya, as respondents. A researcher-developed questionnaire covered early reading strategies, early numeracy strategies, perceived effectiveness, and implementation challenges. Data were analyzed using frequency, percentage, mean, and standard deviation. Findings showed that early reading ($M = 3.48$, $SD = 0.43$) and numeracy strategies ($M = 3.43$, $SD = 0.45$) were highly implemented. Reading ($M = 3.51$, $SD = 0.41$) and numeracy strategies ($M = 3.46$, $SD = 0.43$) were also perceived as highly effective. Storytelling and shared reading, vocabulary development, counting and number recognition, and manipulatives emerged as prominent practices. Implementation challenges ($M = 3.05$, $SD = 0.55$) included insufficient instructional materials, differences in pupils' readiness, limited instructional time, and difficulty providing individualized support. The findings emphasize the value of varied, interactive, developmentally appropriate, and differentiated approaches to foundational learning. The study supports Sustainable Development Goal 4 and contributes to educational sustainability by identifying instructional practices and support needs relevant to kindergarten education.

Keywords: Early Literacy; Early Numeracy; Intervention Strategies; Kindergarten Education; Reading Skills; Teacher Practices

1. Introduction

Early reading and numeracy provide essential foundations for children's subsequent academic development. Kindergarten learners develop oral language, vocabulary, phonological awareness, print knowledge, counting, number recognition, and number relationships. Effective early literacy instruction addresses multiple domains, including language, phonological awareness, print knowledge, decoding, and early writing (Herrera et al., 2021), while interventions combining language and code-related skills can improve emergent literacy outcomes (Cusiter et al., 2025). Early numeracy is similarly multidimensional. Counting, number relations, and basic arithmetic are central early competencies (D. Devlin et al., 2022), while number knowledge, relationships, and operations predict later mathematics achievement (B. L. Devlin et al., 2022). Developmentally appropriate instruction therefore requires meaningful opportunities for children to explore language, numbers, patterns, and mathematical relationships. Guided play can further support selected early mathematics outcomes by combining children's active participation with purposeful adult guidance (Skene et al., 2022). In the Philippines, foundational literacy and numeracy are priorities of curriculum reform (DepEd, 2023a). The MATATAG Kindergarten Curriculum integrates literacy, language and communication, mathematics, and other developmental domains while promoting developmentally appropriate and play-based learning (DepEd, 2023b). Against this background, the

study examined intervention strategies used to develop early reading and numeracy skills among kindergarten pupils in Ambaguio District, Nueva Vizcaya, focusing on their extent of implementation, perceived effectiveness, and implementation challenges.

Early literacy development requires coordinated attention to language, phonological awareness, print knowledge, decoding, and early writing (Herrera et al., 2021). Combined language and code interventions can support emergent literacy development, particularly among preschool children at risk for reading difficulties (Cusiter et al., 2025). Shared and dialogic reading also encourage language development and children's active participation through questions, prompts, and discussion (Noble et al., 2019; Pillinger & Vardy, 2022). Technology may supplement these approaches, with e-book and educational technology interventions showing potential for supporting early literacy when appropriately integrated into instruction (Bautista et al., 2024; Savva et al., 2022). Early numeracy encompasses counting, number relationships, arithmetic, and related mathematical competencies (D. Devlin et al., 2022). These early number competencies are associated with later mathematics performance (B. L. Devlin et al., 2022), supporting the use of counting activities, manipulatives, quantity comparisons, number games, and meaningful numerical experiences. Guided play may also enhance selected mathematics outcomes when purposeful teacher guidance is incorporated into child-centered learning (Skene et al., 2022). Appropriate assessment remains important in distinguishing perceived instructional effectiveness from children's directly measured mathematical outcomes (Outhwaite et al., 2024). Overall, the literature supports a multidimensional approach to early reading and numeracy. Shared reading, phonological activities, guided practice, manipulatives, games, and guided play serve complementary purposes and should be aligned with children's developmental needs and instructional objectives.

Locally, the study focused on kindergarten instructional practices in Ambaguio District, Nueva Vizcaya. Rather than assuming particular literacy or numeracy deficiencies among pupils, it examined the strategies teachers use within the defined educational context. Nationally, foundational literacy and numeracy are priorities of the revised Philippine curriculum (DepEd, 2023a). The MATATAG Kindergarten Curriculum integrates language, literacy and communication, mathematics, and other developmental domains, while DepEd has provided professional development to support its implementation (DepEd, 2023b, 2024). Kindergarten resources likewise address alphabet knowledge, oral language, listening comprehension, numbers, number sense, and other foundational competencies (DepEd, 2025). Globally, foundational learning remains an educational concern. UNICEF (2022) identifies reading and numeracy as fundamental building blocks for future learning, while the World Bank (2022) emphasizes foundational reading in addressing learning poverty. These priorities reinforce the importance of strengthening literacy and numeracy during the early years.

The study was anchored in Vygotsky's Sociocultural Theory, which emphasizes the role of social interaction and guided participation in children's cognitive development (Vygotsky, 1978). Through the Zone of Proximal Development, children can accomplish increasingly complex tasks with appropriate assistance and scaffolding. The theory is relevant to early literacy and numeracy strategies involving teacher modeling, questioning, prompting, guided practice, shared reading, guided play, small-group activities, and manipulatives. Conceptually, the study examined teachers' reading and numeracy intervention strategies in terms of their extent of implementation, perceived effectiveness, and implementation challenges. Perceived effectiveness represented teachers' professional assessment of the strategies rather than direct evidence of causal improvement in pupil achievement.

Existing research provides substantial evidence on early literacy interventions, shared reading, early number competencies, and guided play (Cusiter et al., 2025; B. L. Devlin et al., 2022; Herrera et al., 2021; Skene et al., 2022). However, international findings do not necessarily describe how such strategies are implemented within particular Philippine school districts. The study therefore addressed a contextual gap by examining the intervention strategies used by kindergarten teachers in Ambaguio District, their extent of implementation, perceived effectiveness, and implementation challenges. The findings may provide a basis for instructional planning, professional development, resource provision, and future intervention research within the local educational context.

The study aligns with Sustainable Development Goal 4: Quality Education, which promotes inclusive and equitable quality education and lifelong learning opportunities. Strengthening foundational reading and numeracy during kindergarten supports children's preparation for subsequent schooling, while identifying implementation challenges can guide improvements in instructional support. The study contributes to educational, social, and institutional sustainability by identifying instructional practices that can support foundational learning within regular kindergarten education. Evidence on intervention practices and implementation challenges can inform teacher development, instructional supervision, and resource allocation, supporting sustained improvements in early education (DepEd, 2024; UNICEF Philippines, 2023).

2. Material and methods

2.1 Research Design

The study employed a descriptive quantitative research design to examine intervention strategies for developing early reading and numeracy skills among kindergarten pupils. It assessed the extent of implementation of reading and numeracy strategies, their perceived effectiveness, and challenges encountered in their implementation. The descriptive approach was appropriate because the study examined existing instructional practices without manipulating classroom conditions.

2.2 Locale of the Study

The study was conducted in Ambaguio District, Nueva Vizcaya, Philippines, covering kindergarten education across schools within the district, including Hamhahamaan Elementary School. The district provided the setting for examining strategies used to develop foundational literacy and numeracy competencies.

2.3 Respondents of the Study

The respondents consisted of kindergarten teachers from schools within Ambaguio District. They were selected because they were directly involved in planning and implementing classroom activities for developing foundational reading and numeracy skills. The study focused on their instructional practices, perceptions of effectiveness, and challenges encountered in implementing the strategies.

2.4 Sample and Sampling Procedure

Total enumeration was employed because the target population consisted of a specific group of kindergarten teachers within the district. Teachers assigned to kindergarten classes in Ambaguio District were included, while teachers handling other grade levels were excluded. This approach provided broad representation of kindergarten instructional practices within the defined research setting.

2.5 Research Instrument

The study utilized a structured researcher-developed questionnaire based on the research objectives and related literature on early literacy and numeracy. The instrument covered early reading strategies, early numeracy strategies, perceived effectiveness, and implementation challenges. Reading items included phonological awareness, letter and print recognition, vocabulary development, storytelling and shared reading, language games, guided practice, and differentiated or small-group instruction. Numeracy items included counting and number recognition, quantity comparison, number relationships, manipulatives, mathematics games, guided play, patterns, and contextualized numerical activities. A four-point Likert scale measured implementation from 1 (Not Implemented) to 4 (Highly Implemented). Perceived effectiveness ranged from 1 (Not Effective) to 4 (Highly Effective), while implementation challenges ranged from 1 (Not Encountered) to 4 (Highly Encountered). The instrument underwent content review to ensure alignment of the items with the objectives and constructs examined.

2.6 Data Gathering Procedure

Permission to conduct the study was coordinated with the appropriate school authorities before administration of the research instrument. The purpose of the study and instructions for answering the questionnaire were communicated to the respondents. Participation was voluntary, and completed questionnaires were checked for completeness before responses were coded and organized for statistical analysis. Personally identifiable information was excluded from the analytical dataset, and responses were treated confidentially.

2.7 Data Analysis Techniques

Descriptive statistics were used to analyze the data. Frequency and percentage summarized categorical information, while mean and standard deviation determined the extent of implementation, perceived effectiveness, and implementation challenges. Mean scores of 3.26-4.00 were interpreted as Highly Implemented/Highly Effective/Highly Encountered; 2.51-3.25 as Implemented/Effective/Encountered; 1.76-2.50 as Less Implemented/Less Effective/Less Encountered; and 1.00-1.75 as Not Implemented/Not Effective/Not Encountered. Descriptive ranking was used to identify the most prominent strategies and challenges.

2.8 Ethical Considerations

Ethical principles for research involving children were observed throughout the study. Permission to conduct the study was obtained from the appropriate school authorities, and informed consent was secured from the parents or legal guardians of the participating Grade 3 pupils. Participation was voluntary and did not affect the pupils' grades, regular instruction, or access to educational support. Confidentiality and privacy were maintained through coded participant information and secure handling of assessment records. No personally identifiable information was disclosed, and findings were reported only in aggregated form. These measures ensured the protection of the rights, privacy, and welfare of the participating pupils throughout the study.

3. Results and Discussion

3.1 Pre-Intervention Mathematical Problem-Solving Performance

3.1.1 Pretest Performance of Grade 3 Pupils

Before the intervention, the pupils obtained an overall mathematical problem-solving mean score of 48.60 (SD = 11.40) out of 100. Among the four dimensions, understanding the problem obtained the highest mean ($M = 13.20$), followed by carrying out the solution ($M = 12.40$) and identifying the appropriate operation or strategy ($M = 12.00$). Obtaining and checking the answer registered the lowest mean ($M = 11.00$). The pretest performance indicates that difficulties were present at different stages of the problem-solving process. Although pupils demonstrated some ability to understand mathematical situations, lower performance in selecting strategies and completing and checking solutions suggests that interpreting a problem did not necessarily lead to a successful solution. This is consistent with research showing that mathematical word-problem performance depends on the interaction of numerical knowledge, linguistic characteristics, problem structure, and strategic reasoning (Vessonen et al., 2024).

3.2 Post-Intervention Mathematical Problem-Solving Performance

3.2.1 Posttest Performance of Grade 3 Pupils

After the intervention, the overall mean increased to 61.30 (SD = 10.80). Understanding the problem increased to $M = 16.30$, carrying out the solution to $M = 15.50$, identifying the appropriate operation or strategy to $M = 15.10$, and obtaining and checking the answer to $M = 14.40$. The posttest pattern indicates improvement across the different stages required to solve mathematical problems. Rather than focusing exclusively on computation, the intervention provided opportunities for pupils to interpret problem statements, identify relevant information, select operations, observe modeled solutions, engage in guided practice, and work progressively toward independent problem solving. This pattern is consistent with evidence supporting explicit and structured mathematical word-problem interventions. Myers et al. (2022) found positive effects of word-problem interventions among elementary learners experiencing mathematics difficulties. Similarly, Vessonen et al. (2025) reported substantial benefits from mathematical word-problem interventions across a large body of elementary-level studies. The present pattern therefore supports the instructional value of combining comprehension, strategy selection, and mathematical procedures within targeted numeracy support.

3.3 Changes Across Mathematical Problem-Solving Dimensions

3.3.1 Pretest-Posttest Performance

Improvement occurred across all four dimensions of mathematical problem solving. Understanding the problem increased from $M = 13.20$ to $M = 16.30$, representing a gain of 3.10 points. Identifying the appropriate operation or strategy increased from $M = 12.00$ to $M = 15.10$, also a gain of 3.10 points. Carrying out the solution increased from $M = 12.40$ to $M = 15.50$, producing another 3.10-point gain. Obtaining and checking the answer increased from $M = 11.00$ to $M = 14.40$ and showed the largest descriptive gain at 3.40 points. The pattern suggests that improvement was distributed across the problem-solving process rather than being limited to computational execution. The relatively stronger gain in obtaining and checking answers is noteworthy because this dimension had the lowest baseline score. Guided solution procedures and opportunities to review completed work may have provided additional support for a skill that was initially less developed. At the same time, the dimension-level differences were descriptive. No separate inferential tests were conducted to determine whether improvement in one dimension was statistically greater than improvement in another. Therefore, the results should not be interpreted as demonstrating that the intervention was more effective for one problem-solving dimension than for the others.

3.4 Difference Between Pretest and Posttest Performance

3.4.1 Statistical Significance of the Improvement

Overall mathematical problem-solving performance increased from 48.60 (SD = 11.40) in the pretest to 61.30 (SD = 10.80) in the posttest, corresponding to a mean gain of 12.70 points. A paired-samples t test showed that the pretest-posttest difference was statistically significant, $t(29) = 7.32$, $p < .001$. The null hypothesis of no significant difference between the two assessment periods was therefore rejected. The corresponding effect size was Cohen's $d = 1.34$, indicating a large standardized pretest-posttest difference. These results are consistent with previous intervention research. Myers et al. (2022) found that structured word-problem interventions can produce meaningful improvements among elementary learners experiencing mathematics difficulties. Vessonen et al. (2025) likewise reported a large average effect across mathematical word-problem interventions, although the magnitude of outcomes varied according to intervention and implementation characteristics. For the present study, the statistical result indicates that pupils performed substantially better after the intervention than they did at baseline. However, because the research employed a one-group pretest-posttest design, the significant difference should be interpreted as improvement associated with participation in the ARAL Numeracy Program, rather than definitive evidence that the program alone caused the improvement.

3.5 Comprehension in Mathematical Problem Solving

3.5.1 Understanding Mathematical Word Problems

The understanding-the-problem dimension increased from $M = 13.20$ at pretest to $M = 16.30$ at posttest. This dimension reflected pupils' ability to interpret the mathematical situation, determine what the problem was asking, and recognize information relevant to the solution. The improvement is important in relation to the original instructional concern because mathematical word problems require pupils to process written information before performing mathematical operations. A learner may possess computational knowledge but still experience difficulty when unable to interpret the relationships expressed in a word problem. Research has similarly identified linguistic and structural characteristics as factors influencing elementary pupils' mathematical word-problem performance (Vessonen et al., 2024). The finding should not, however, be interpreted as evidence of improvement in general reading comprehension. The study measured comprehension within mathematical problem solving and did not administer a separate standardized reading-comprehension assessment. The results therefore indicate stronger interpretation of mathematical word problems rather than a generalized improvement in reading ability.

3.6 Overall Findings

3.6.1 Effectiveness of the ARAL Numeracy Intervention

Taken together, the findings indicate that Grade 3 pupils demonstrated higher mathematical problem-solving performance following the ARAL Numeracy intervention. Improvement was evident in understanding problems, identifying appropriate strategies or operations, carrying out solutions, and obtaining and checking answers. The overall pretest-posttest difference was statistically significant and was accompanied by a large effect size. The findings suggest that a structured intervention combining mathematical comprehension, explicit modeling, guided practice, operation selection, and systematic solution procedures can provide useful support for pupils experiencing difficulty with mathematical word problems. This instructional approach is consistent with research emphasizing systematic and targeted intervention for elementary learners with mathematics difficulties (Myers et al., 2022; Vessonen et al., 2025). Nevertheless, the design does not permit the observed improvement to be attributed exclusively to the ARAL Numeracy Program. Without a comparison group, other influences such as regular classroom instruction, repeated exposure to similar mathematical tasks, maturation, or testing effects cannot be completely excluded. The findings therefore provide evidence of improved performance following participation in the intervention while supporting the need for stronger controlled designs in future evaluations.

4. Conclusion & Recommendations

The study found that Grade 3 pupils demonstrated improved mathematical problem-solving performance following the implementation of the ARAL Numeracy Program. Higher posttest performance was observed across the four assessed dimensions: understanding the problem, identifying the appropriate operation or strategy, carrying out the solution, and obtaining and checking the answer. The significant difference between pretest and posttest scores, together with the large effect size, indicates substantial improvement in pupils' mathematical problem-solving performance following participation in the intervention. The findings highlight the value of structured numeracy support that integrates comprehension of mathematical situations, explicit modeling, guided practice, strategic selection of operations, and systematic solution procedures. Overall, the ARAL Numeracy Program provided a useful instructional approach for strengthening the mathematical problem-solving skills of Grade 3 pupils.

Grade 3 mathematics teachers are encouraged to continue using structured numeracy interventions that integrate comprehension of mathematical word problems, explicit modeling, guided practice, and systematic problem-solving strategies. Particular attention should be given to learners who continue to experience difficulty in interpreting problems, selecting appropriate operations, and independently completing solutions. Mallabo Elementary School and concerned educational administrators may support sustained implementation through appropriate learning materials, progress monitoring, and professional development related to numeracy intervention. Future studies may examine the program using larger samples, longer intervention periods, multiple schools within San Mariano I District, and comparison or control groups to provide stronger evidence regarding intervention effectiveness.

The study was limited to Grade 3 pupils within a specific elementary school context and employed a one-group pretest-posttest design. Although significant improvement was observed after the intervention, the absence of a comparison or control group limits the extent to which the improvement can be attributed exclusively to the ARAL Numeracy Program. Other factors, including regular mathematics instruction, maturation, and repeated exposure to problem-solving tasks, may have influenced pupil performance. The assessment also focused on mathematical problem solving and comprehension within mathematical word problems; therefore, the findings should not be interpreted as evidence of improvement in general reading comprehension. These limitations should be considered when applying the findings to other grade levels, schools, or educational settings.

5. Compliance with ethical standards

The authors affirm that no conflicts of interest exist in relation to this study. Ethical principles for research involving children were observed throughout the research process. Permission to conduct the study was obtained from the appropriate school authorities, and informed consent was secured from the parents or legal guardians of the participating Grade 3 pupils. Participation was voluntary and did not affect the pupils' grades, regular instruction, or access to educational support. Confidentiality and privacy were maintained through coded participant information, secure handling of assessment records, and aggregated reporting of findings. No personally identifiable information was disclosed. The researchers acknowledge the participating Grade 3 pupils, their parents or legal guardians, Mallabo Elementary School, and the concerned educational authorities for their participation and institutional support.

REFERENCES

- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.
- Department of Education. (2023). *MATATAG curriculum: Mathematics curriculum guide*. Department of Education, Republic of the Philippines.
- Department of Education. (2025a). *Implementing guidelines for the Academic Recovery and Accessible Learning (ARAL) Program*. Department of Education, Republic of the Philippines.
- Department of Education. (2025b). *Implementing rules and regulations of Republic Act No. 12028, otherwise known as the Academic Recovery and Accessible Learning (ARAL) Program Act*. Department of Education, Republic of the Philippines.
- Department of Education. (2025c). *Implementing guidelines for the Academic Recovery and Accessible Learning Program in reading for Key Stages 1 to 3*. Department of Education, Republic of the Philippines.
- Department of Education. (2026). *DepEd ARAL Program, promising ang initial result sa learning recovery; plano pa palakasin sa 2026*. Department of Education, Republic of the Philippines.
- Department of Education, Southeast Asian Ministers of Education Organization, & UNICEF. (2021). *Southeast Asia Primary Learning Metrics 2019 national report of the Philippines*. UNICEF Philippines.
- Department of Education & UNICEF. (2021). *Southeast Asia Primary Learning Metrics 2019 supplementary report: An analysis of contextual variables*. UNICEF Philippines.
- Myers, J. A., Witzel, B. S., Powell, S. R., Li, H., Pigott, T. D., Xin, Y. P., & Hughes, E. M. (2022). A meta-analysis of mathematics word-problem solving interventions for elementary students who evidence mathematics difficulties. *Review of Educational Research*, 92(5), 695-742. doi:10.3102/00346543211070049
- Organisation for Economic Co-operation and Development. (2023a). *PISA 2022 results (Volume I): The state of learning and equity in education*. OECD Publishing. doi:10.1787/53f23881-en
- Organisation for Economic Co-operation and Development. (2023b). *PISA 2022 results (Volume II): Learning during—and from—disruption*. OECD Publishing. doi:10.1787/a97db61c-en
- Organisation for Economic Co-operation and Development. (2023c). *PISA 2022 results: Country note—Philippines*. OECD Publishing.
- Polya, G. (2004). *How to solve it: A new aspect of mathematical method*. Princeton University Press. (Original work published 1945)
- Republic of the Philippines. (2024). *Republic Act No. 12028: Academic Recovery and Accessible Learning (ARAL) Program Act*. Official Gazette of the Republic of the Philippines.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Houghton Mifflin.
- UNICEF. (2022). *Are children really learning? Exploring foundational skills in the midst of a learning crisis*. United Nations Children's Fund.
- UNICEF Philippines. (2023). *Southeast Asia Primary Learning Metrics 2019: Policy brief series*. United Nations Children's Fund Philippines.
- United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development*. United Nations.
- Vessonen, T. (2025). Understanding mathematical word problem-solving skills among elementary schoolers through meta-analyses. *LUMAT-B: International Journal on Math, Science and Technology Education*, 10(1).
- Vessonen, T., Dahlberg, M., Hellstrand, H., Aunio, P., & Laine, A. (2024). Task characteristics associated with mathematical word problem-solving performance among elementary school-aged children: A systematic review and meta-analysis. *Educational Psychology Review*, 36, 117. doi:10.1007/s10648-024-09954-2
- Vessonen, T., Dahlberg, M., Hellstrand, H., Widlund, A., Söderberg, P., Korhonen, J., Aunio, P., & Laine, A. (2025). Individual characteristics associated with elementary school children's mathematical word problem-solving skills: A systematic review and meta-analysis. *Review of Education*, 13(1), e70045. doi:10.1002/rev3.70045
- Vessonen, T., Hellstrand, H., Kurkela, M., Aunio, P., & Laine, A. (2025). The effectiveness of mathematical word problem-solving interventions among elementary schoolers: A systematic review and meta-analysis. *International Journal of Educational Research*, 132, 102642. doi:10.1016/j.ijer.2025.102642