Formosa Journal of Sustainable Research (FJSR)
Vol. 5, No. 10 2026: 861-874

Developing a Numeracy Learning Program through Observation, Exploration, and Reflection for Children Aged 5 to 6 Years: An ADDIE-Based Study

Prihastuti[1]*, Yazid[2], Kurniasari[3], Dewi Syarifah[4], Sriwatini[5], Erna Budiarti[6], Imamah[7], Ajat[8]
Universitas Panca Sakti Bekasi
Corresponding Author: Prihastuti balipintartuti@gmail.com

A R T I C L E I N F O

Keywords: ADDIE, Early Childhood Education, Early Numeracy, Implementation Fidelity, Learning Program Development

Received : 24, June
Revised : 26, August
Accepted: 28, October

©2026 Prihastuti, Yazid, Kurniasari, Syarifah, Sriwatini, Budiarti, Imamah, Ajat: This is an open-access article distributed under the termsof the Creative Commons Atribusi 4.0 Internasional.

A B S T R A C T

This study developed and evaluated an Observe–Explore–Reflect (OER) numeracy learning program for children aged 5–6 years. The program was designed to provide early childhood teachers with a structured approach to concrete, play-based numeracy experiences. An educational research-and-development approach guided by the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model was employed at Denpasar Children Center Kindergarten, Bali, Indonesia, from April to July 2026. The product comprised a teacher's guidebook and eight learning activity modules. Two early childhood education content experts and one media expert assessed product feasibility. Implementation involved 20 kindergarten children, two classroom teachers, and one teacher-observer. Data were collected through teacher needs assessment, expert-rating forms, a program implementation fidelity sheet, and a 28-item numeracy development assessment administered before and after implementation.

INTRODUCTION

Early numeracy refers to children's developing ability to make sense of numbers, quantities, patterns, shapes, measurement, and simple mathematical relationships in everyday situations. Rather than being restricted to numeral recognition or rote counting, early numeracy involves manipulating objects, comparing amounts, ordering materials, recognizing regularities, and interpreting practical problems. These competencies provide an important foundation for subsequent mathematical learning (Purpura & Lonigan, 2015). Developmentally appropriate instruction therefore begins with meaningful and concrete experiences rather than formal symbolic exercises alone (National Association for the Education of Young Children [NAEYC], 2020; NAEYC & National Council of Teachers of Mathematics [NCTM], 2010).

The challenge of developing mathematical understanding is relevant to Indonesian education. According to the Organisation for Economic Co-operation and Development (OECD, 2023), Indonesia's mean mathematics score in PISA 2022 was 366, compared with the OECD average of 472. PISA assesses 15-year-old students and does not measure preschool numeracy; nevertheless, these results place mathematical learning within a wider educational context and reinforce the value of attending to foundational learning opportunities early in life. For children aged 5–6 years, this means creating repeated opportunities to see, handle, compare, and discuss quantities in familiar settings.

Theoretical perspectives on early learning support such an approach. Piaget (1964) conceptualized children as active constructors of knowledge, suggesting that encounters with objects and events can support the development of mental representations. Vygotsky (1978) placed additional emphasis on social interaction, language, and guided assistance within the zone of proximal development. Together, these perspectives suggest that teachers can establish meaningful numeracy experiences by selecting concrete stimuli, supporting exploration, encouraging mathematical communication, and adapting assistance to each child's current abilities. In line with these perspectives, studies of early childhood education have examined activity-based and guided approaches for strengthening children's conceptual learning (Burns et al., 2025; Gracia & Watini, 2022).

Recent Indonesian studies have contributed evidence on instructional resources for emergent numeracy. Saqinah and Yuliantina (2024) examined project-based learning supported by interactive activity books, whereas Purba et al. (2026) developed e-comic media for numeracy-literacy experiences in early education. Agustia and Fitriani (2025) investigated a numeracy activity-book innovation, and Ambayati et al. (2025) used the ADDIE framework to develop an instructional counting medium. Budiarti (2025) also discussed contextual and technology-supported approaches to early mathematical learning. These studies highlight the pedagogical value of engaging learning resources, but their respective emphases differ from a coherent, teacher-facing sequence implemented across a set of integrated numeracy modules.

An important practical need identified in the thesis underlying this article was for a program that specifies learning aims, materials, teacher and child activities, instructional sequence, learning environments, and assessment procedures in a single operational guide. A resource of this kind may help teachers connect isolated numeracy tasks into consistent learning experiences while preserving the flexibility required for young children. The present study therefore developed an Observe–Explore–Reflect (OER) program, translating the Indonesian stages Amati, Eksplorasi, and Refleksi into an English instructional sequence. In the Observe stage, children attend to concrete objects or situations; during Explore, they manipulate materials and test emerging ideas; during Reflect, they communicate and revisit their observations and learning.

The study addressed four linked questions: (1) What instructional needs should inform program development? (2) How can the OER sequence be operationalized in a teacher's guidebook and eight modules? (3) How feasible is the resulting product according to content and media experts, and how faithfully can it be implemented? (4) How do children's numeracy assessment scores change between the initial and final measurements? By examining product development, expert judgments, implementation fidelity, and paired assessments in one setting, the study offers a practice-oriented account of a structured early numeracy program rather than a controlled estimate of intervention effectiveness.

LITERATURE REVIEW

Early Numeracy in Early Childhood Education

Early numeracy is a multidimensional developmental competence encompassing children's understanding of numbers and quantities, counting, classification, pattern recognition, spatial and geometric relationships, comparison, measurement, and the application of mathematical ideas to familiar situations. It extends beyond recognizing numeral symbols or reproducing counting sequences. Purpura and Lonigan (2015) emphasize the importance of assessing distinct components of preschool numeracy, highlighting the need to consider how young children understand mathematical concepts rather than treating numeracy as a single isolated skill. Accordingly, learning experiences for children aged 5–6 years should connect emerging mathematical ideas with objects, actions, and situations that are accessible within their daily environments.

The National Association for the Education of Young Children and the National Council of Teachers of Mathematics (NAEYC & NCTM, 2010) advocate meaningful mathematical experiences in early childhood, while NAEYC (2020) emphasizes developmentally appropriate practice responsive to children's developmental characteristics, individual differences, and contexts. These positions support the use of concrete materials, purposeful play, guided interaction, and opportunities to explain or demonstrate mathematical understanding. They also suggest that numeracy learning should encompass several interrelated domains rather than relying predominantly on worksheets or memorization of numerals.

Constructivist and Sociocultural Foundations

Two complementary perspectives inform the instructional design of early numeracy programs. From a constructivist perspective, Piaget (1964) describes children as active participants in the development of knowledge. During the preoperational years, experiences with observable objects and hands-on actions provide important foundations for forming and revising mathematical representations. For example, comparing groups of objects or arranging materials into a pattern allows children to engage directly with relationships that may be difficult to understand through verbal explanations alone.

Vygotsky's (1978) sociocultural perspective extends this account by emphasizing the role of interaction, language, and assistance from more knowledgeable others. Within the zone of proximal development, teachers can support children through modeling, prompts, questions, and gradually adjusted guidance. Mathematical talk is especially relevant because explaining how objects were grouped, counted, or compared can make children's emerging reasoning visible to both learners and teachers. Considered together, these theories provide a rationale for learning activities that combine active manipulation with intentional adult support. A systematic review and meta-analysis by Burns et al. (2025) further places the teaching of problem-solving skills within the broader literature on science, technology, engineering, and mathematics activities in early childhood settings.

Play-Based Experiences and the Observe, Explore, and Reflect Sequence

Concrete, activity-based learning offers a practical means of translating these theoretical principles into early numeracy instruction. Gracia and Watini (2022) examined numerical and scientific literacy experiences through activities involving direct engagement, while Budiarti (2025) discussed interactive and contextual opportunities for early mathematical learning. These studies are relevant to instructional approaches that encourage children to attend to mathematical properties in their surroundings, manipulate materials, and communicate what they have discovered. However, activity-based learning alone does not specify how separate experiences should be organized into a consistent instructional sequence.

The Observe, Explore, and Reflect (OER) sequence examined in the present study was designed to provide such organization. During Observe (Amati), children focus on objects, examples, or everyday situations to identify numeracy-related features. During Explore (Eksplorasi), they manipulate and compare materials, count objects, form groups, investigate patterns, and test simple solutions. During Reflect (Refleksi), they describe, demonstrate, or revisit their actions and findings with teacher guidance. These stages are an instructional design developed for the program, not a claim that OER has already been independently established as a validated learning theory. Their proposed value lies in linking concrete experience, active investigation, and age-appropriate mathematical communication within each learning activity (Piaget, 1964; Vygotsky, 1978; NAEYC, 2020).

Previous Research on Early Numeracy Learning Resources

Recent studies in the Indonesian early childhood context have explored different ways to support numeracy through instructional resources. Saqinah and Yuliantina (2024) investigated project-based learning supported by interactive activity books in relation to children's literacy and numeracy. Agustia and Fitriani (2025) developed the "Magic Numbering" activity-book innovation, focusing on numeracy-supporting materials. Purba et al. (2026) reported the development and practical use of e-comic media for numeracy and literacy in early education. Similarly, Ambayati et al. (2025) applied the ADDIE approach to developing an instructional counting apron for children aged 5–6 years. Budiarti (2025) considered interactive educational technology as a way of enriching early childhood mathematics learning.

Collectively, these contributions indicate continued interest in concrete, engaging, and context-sensitive resources for early mathematical learning. They also illustrate differences in the instructional unit being developed: an activity book, digital medium, counting aid, or particular learning activity. The present study builds on this literature while shifting attention from an individual resource to a teacher-facing program that integrates instructional objectives, classroom roles, learning materials, eight numeracy content modules, developmental assessment, and implementation guidance. This distinction concerns the scope and organization of the proposed product; it does not imply that the earlier approaches are ineffective or that no other integrated programs exist.

Development Framework and Research Gap

Research and development offers a systematic process for moving from identified educational needs to the design, expert review, revision, and implementation of learning products (Sugiyono, 2009; Haryati, 2012; Waruwu, 2024). Within this approach, the ADDIE model organizes work into Analysis, Design, Development, Implementation, and Evaluation. Its value for the present study is that decisions about objectives, age-appropriate learning activities, media, assessment, and classroom application can be addressed as connected design tasks rather than as independent components. The use of ADDIE in related early childhood material development is also illustrated by Ambayati et al. (2025).

The literature reviewed above provides support for early numeracy, concrete activity-based experiences, teacher scaffolding, and the development of engaging resources. A more specific issue addressed in the present research is how these elements can be combined into one operational program that teachers can deliver repeatedly across distinct numeracy domains and evaluate through both expert judgments and classroom implementation records. Accordingly, the study developed a teacher's guidebook with eight modules organized around OER, then examined expert-assessed feasibility, implementation fidelity, and within-group changes in children's numeracy scores. These outcomes address product development and preliminary implementation, while the absence of a comparison group limits any causal interpretation of changes in learning.

METHODOLOGY

Research Design and Setting

This educational research-and-development study used the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. Research and development provides a structured pathway from a documented instructional need to a designed, reviewed, revised, and field-implemented product (Haryati, 2012; Sugiyono, 2009; Waruwu, 2024). Fieldwork was conducted at Denpasar Children Center Kindergarten, Denpasar, Bali, Indonesia, during the second semester of the 2025/2026 academic year (April–July 2026). Product development and evaluation were complemented by a single-group, paired initial–final assessment to document changes in children's numeracy scores. No comparison group or random allocation was reported.

Participants and Roles

The implementation involved 20 children aged 5–6 years in Kindergarten Group B. Two classroom teachers delivered the activities using the teacher's guidebook, and one teacher-observer recorded implementation fidelity. A classroom teacher involved in instruction completed both the initial and final numeracy assessments for the same children. Product review was conducted by two early childhood education content experts and one media expert. The selection of this particular school and age group was based on alignment with the program's intended users and the school's readiness to participate; the source thesis did not report probability sampling.

The OER Program and Development Procedure

During Analysis, teacher interviews and a Google Forms needs questionnaire were used to identify existing numeracy practices, difficulties, and requirements for a practical teaching guide. Design translated these requirements into activity objectives, content, the OER sequence, teacher and child roles, learning materials, classroom arrangements, and assessment provisions. Development produced an initial guidebook and eight modules, followed by expert validation and revision. Implementation involved the complete sequence of eight modules. Evaluation synthesized validation ratings, observer records, and children's assessment scores; expert feedback also informed refinements to instructions, illustrations, activity contexts, and opportunities for children to demonstrate their thinking.

Table 1. Operational Sequence of The Observe–Explore–Reflect Program

Stage	Child's principal activity	Teacher's principal role
Observe (Amati)	Attend to objects, images, examples, or numeracy situations.	Prepare concrete stimuli and ask orienting questions.
Explore (Eksplorasi)	Count, sort, compare, order, make patterns, and manipulate materials.	Facilitate active trials and provide appropriate scaffolding.
Reflect (Refleksi)	Show, describe, or explain a solution or learning experience.	Prompt child-appropriate reflection and reinforce understanding.

The final teaching product comprised one teacher's guidebook and eight learning activity modules. Each module specified numeracy objectives, materials, activity steps, roles of teachers and children, and assessment guidance. The guidebook organized these elements around concrete objects, play-based experiences, and situations familiar to children. The eight modules are summarized in Table 2.

Table 2. Eight Numeracy Learning Activity Modules

Module	Content focus	Intended numeracy experience
1	Recognizing numeral symbols	Recognizing numbers and their written symbols.
2	Counting objects	Counting and understanding quantities.
3	Sorting objects	Grouping items by selected characteristics.
4	Recognizing patterns	Recognizing and extending simple patterns.
5	Comparing size and quantity	Comparing objects or sets by size and quantity.
6	Recognizing geometric shapes	Identifying and differentiating basic shapes.
7	Ordering objects	Ordering by size, number, or relevant attributes.
8	Solving simple numeracy problems	Using early numeracy to address concrete everyday tasks.

Measures and Data Collection

Teacher needs were documented through interviews and a structured online needs questionnaire. Product feasibility was evaluated on four-point expert-rating forms covering material alignment, learning objectives, age appropriateness, the OER learning sequence, instructional presentation, readability, layout, and the quality of media. For each expert assessment, the feasibility percentage was calculated as the obtained score divided by the maximum possible score, multiplied by 100. The content review included 46 scored items per expert; the single media review had a maximum score of 188.

Implementation was monitored with the Program Implementation Fidelity Sheet (FIP-01). The teacher-observer rated preparation, the three stages of the activity, teacher guidance, children's participation, use of concrete materials, and closure on a 1–4 scale, from not implemented to implemented very well. Observer notes provided additional qualitative details, including skills requiring further child-specific support. The thesis reports the ordinal implementation categories for the eight modules rather than a complete per-module set of numerical fidelity percentages.

Children's numeracy development was measured with the Children's Numeracy Development Assessment (IAN-01), administered before implementation and after all eight modules had been delivered. The methods chapter specifies 28 items with four response levels, giving a maximum total of 112 points. The same classroom-teacher assessor rated the 20 children on both occasions. The instrument was used to document early numeracy competencies; the supplied thesis does not report a separate reliability coefficient for its study implementation. Assessment in early childhood education should interpret observed performance in relation to developmentally appropriate tasks and contexts (Wortham, 2018).

Data Analysis

Expert scores were converted to percentages and interpreted using the feasibility categories defined in the original study. Fidelity findings were summarized by module implementation category. For child assessment scores, totals, means, medians, and observed minimum and maximum values were reported for both time points. The paired Wilcoxon signed-rank test was used to examine the difference between initial and final scores, with the nominal significance threshold set at $\alpha = .05$. Results are reported as stated in the thesis; no participant-level data were available in the supplied main results to reconstruct confidence intervals or standardized effect sizes.

RESEARCH RESULT

Needs Assessment and Product Refinement

The needs assessment indicated that teachers sought a clearer operational sequence for early numeracy activities. Specifically, they needed guidance on instructional objectives, materials, the roles of adults and children, practical learning steps, and developmental assessment. These findings informed a guidebook that integrated concrete materials with a structured Observe–Explore–Reflect sequence. The initial draft of the program was refined after expert review. Revisions included clearer task instructions, strengthened illustrations and instructions in Activity 5, greater attention to real-life contexts, more opportunities for children to produce or demonstrate work, additional follow-up stimulation, and improvements in readability and visual presentation. The final version incorporated these revisions into the teacher's guidebook and the eight modules.

Expert-assessed Product Feasibility

Two subject-matter experts independently evaluated the early childhood numeracy content, and one expert evaluated the media presentation. Table 3 presents the scoring results. The combined content rating was 364 out of 368, corresponding to 98.91%. The media presentation was rated 188 out of 188 (100%). These results fell within the thesis's "highly feasible" classification. They reflect very positive expert judgments about the evaluated product; they do not constitute an independent psychometric validation of children's numeracy assessment.

Table 3. Expert Validation of the Numeracy Learning Program

Expert review	Obtained score	Maximum score	Feasibility
Content expert 1	184	184	100.00%
Content expert 2	180	184	97.83%
Combined content	364	368	98.91%
Media expert	188	188	100.00%

Implementation Fidelity

All eight modules were delivered during the implementation phase. Observer ratings classified five modules as "implemented" and three as "highly implemented." Thus, the planned sequence was completed for all eight modules in the study setting. The field observations also described children's engagement with play-based tasks and concrete materials. However, some children continued to require extra support in counting, recognizing numeral symbols, forming patterns, writing numerals, and comparing quantities. These observations suggest that fidelity to the planned sequence can coexist with individual variation in mastery and the need for differentiated teacher scaffolding.

Changes in Numeracy Scores

The 20 children completed both numeracy assessments. Initial scores summed to 1,581 and final scores to 2,097, giving an aggregate increase of 516 points. Mean scores rose from 79.05 (70.58% of the stated maximum of 112) to 104.85 (93.62%), a mean increase of 25.80 points. The median increased from 79.50 to 106.50. The original analysis also reported that all 20 children achieved higher final scores than initial scores, with none remaining unchanged or decreasing. The observed score distributions are summarized in Table 4 and Figure 1.

Table 4. Numeracy Development Assessment Scores Before and After Implementation

Descriptive statistic	Initial assessment	Final assessment
Number of children	20	20
Total score	1,581	2,097
Mean	79.05	104.85
Median	79.50	106.50
Minimum observed score	49	78
Maximum observed score	99	112

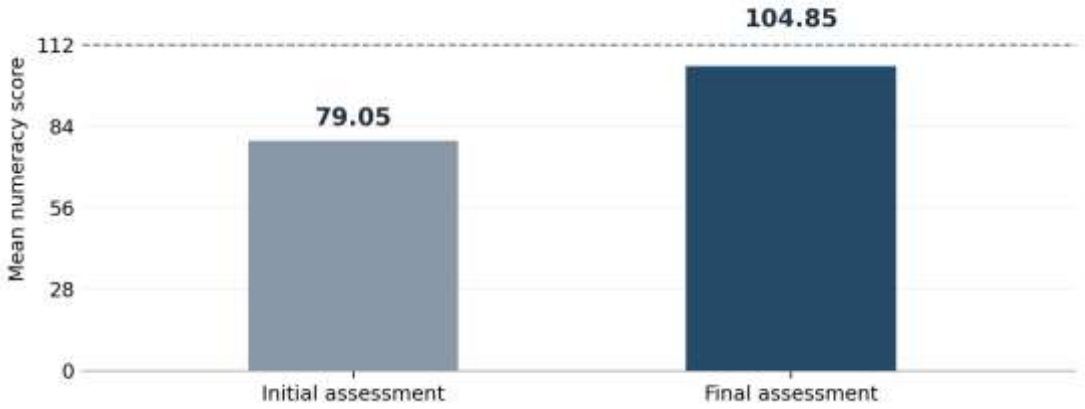


Figure 1. Mean Numeracy Scores Before and After Program Implementation

Figure 1. Mean numeracy development scores at the initial and final assessments (n = 20). Dashed line represents the maximum score of 112; means are based on the thesis results. No measure of variance was reported for this figure. The Wilcoxon signed-rank comparison reported $W = 0.00$ and $p < .001$ for the 20 paired observations ($\alpha = .05$). Accordingly, initial and final numeracy scores differed statistically within this sample. The combination of positive paired changes, a substantial descriptive mean increase, and a significant signed-rank test documents improvement over the measurement period. It does not, on its own, establish that the program was the sole cause of improvement..

DISCUSSION

This study produced a teacher-facing numeracy program that integrates instructional structure with developmentally appropriate activities for children aged 5–6 years. Its principal contribution is the operationalization of three connected learning processes—Observe, Explore, and Reflect—across a full guidebook and eight modules, rather than the development of an individual teaching aid alone. The ADDIE process made it possible to connect needs analysis, instructional design, expert review, revisions, implementation, and evaluation within a coherent development cycle. This program-level emphasis complements studies that have focused on an activity book, interactive resource, e-comic, or counting medium (Agustia & Fitriani, 2025; Ambayati et al., 2025; Purba et al., 2026; Saqinah & Yuliantina, 2024).

The learning sequence is also theoretically defensible. In the Observe stage, objects and examples serve as concrete reference points for concepts that may otherwise be too abstract for young children. The Explore stage creates opportunities for active manipulation, comparison, classification, counting, and trial-and-error reasoning. Reflection then invites children to verbalize or demonstrate what they have done, thereby giving teachers access to children's emerging mathematical understandings. These features are compatible with Piaget's account of active knowledge construction (Piaget, 1964) and Vygotsky's emphasis on social mediation and guided participation (Vygotsky, 1978). The approach also aligns with developmentally appropriate early childhood learning practices and contemporary interest in meaningful, contextualized numeracy experiences (NAEYC, 2020; Budiarti, 2025).

The expert validation scores were uniformly high. Content experts rated the product at 98.91% in aggregate, and the media expert awarded 100%. Such scores suggest that the evaluated features were considered appropriate and clearly presented. However, extremely high ratings should be interpreted in relation to the limited expert panel: two content reviewers and one media reviewer. In a future evaluation, a wider set of experts and a more explicit account of content-validity procedures could better establish the consistency of judgments across raters and aspects. As in other development studies, expert-rated feasibility is best distinguished from demonstrated educational impact.

Implementation observations strengthen the product development account by showing that all eight modules could be delivered in the participating kindergarten. Five modules met the "implemented" category, and three met "highly implemented," indicating generally favorable delivery while leaving room for improvement. The observer's notes are equally informative: difficulties with counting, numeral recognition, patterning, numeral writing, and comparison persisted for some children. These observations reinforce the need for scaffolding, additional repetitions, and differentiation. Rather than implying uniform mastery from high implementation ratings, the findings show that a shared instructional framework still needs to be adjusted to individual learning trajectories.

The initial–final score comparison provides promising, but bounded, evidence of numeracy growth during the program. Mean scores increased by 25.80 points on a 112-point scale, and all 20 children improved according to the thesis. The paired difference was statistically significant ($W = 0.00$, $p < .001$). These observations are consistent with the possibility that structured, concrete activities can support early numeracy learning. They should not be described as a causal estimate of program effectiveness because the study did not include a no-treatment or alternative-instruction comparison group. Natural maturation, practice with the assessment, ordinary classroom experiences, and rater expectations are possible competing explanations for some of the observed change.

Several measurement characteristics require attention before broader claims are made. The final mean of 104.85 approaches the instrument's maximum of 112, raising the possibility of a ceiling effect if children were followed for longer or if the program were compared with another advanced approach. Moreover, the same classroom teacher who helped implement the learning program also provided children's assessments. This procedure offers consistency across time points but does not provide independent or blinded outcome rating. The thesis does not supply reliability estimates for the 28-item scoring instrument in this sample, inter-observer agreement for the fidelity ratings, or follow-up data demonstrating retention. These issues do not negate the observed improvement but narrow the conclusions supported by the evidence.

For practice, the program offers teachers a repeatable planning framework that moves from focused observation to exploration and child-appropriate reflection. The guidebook's module structure may help organize lesson preparation and make numeracy objectives visible in activities involving everyday objects and play. For research, the next step should be a multisite study with a clearly defined comparison condition, a larger and more diverse sample, independent assessors, reported instrument reliability, detailed per-module fidelity scores, and an assessment conducted after a retention interval. Such evidence would clarify whether, how, and for whom this integrated learning sequence adds value beyond usual classroom practice. The program is best understood at present as a highly rated and practicable prototype with favorable preliminary developmental outcomes in one setting.

CONCLUSIONS AND RECOMMENDATIONS

The ADDIE-based development process yielded an Observe–Explore–Reflect numeracy learning program for children aged 5–6 years, consisting of a teacher's guidebook and eight activity modules. Expert reviews rated its content and presentation as highly feasible (98.91% and 100%, respectively), and all modules were implemented in the participating kindergarten. Among 20 children, the mean numeracy score increased from 79.05 to 104.85, with a statistically significant paired difference ($W = 0.00$, $p < .001$). These findings indicate that the product was feasible according to its expert reviewers, implementable in the research context, and associated with improved numeracy scores during the study period. Broader and controlled evaluations are necessary

to establish the program's contribution to learning outcomes and its applicability across settings.

ADVANCED RESEARCH

Future research should involve larger and more diverse samples across early childhood education institutions to examine the broader applicability of the Observe, Explore, and Reflect (OER) numeracy learning program. Experimental or quasi-experimental designs are recommended to provide stronger evidence of its effectiveness. Further studies should also investigate long-term learning outcomes, refine activities requiring additional instructional support, and examine the contribution of each OER stage to children's numeracy development.

ACKNOWLEDGMENT

The author expresses sincere gratitude to Assoc. Prof. Dr. Sri Watini, M.Pd., and Assoc. Prof. Dr. Erna Budiarti, M.Pd., for their invaluable guidance and support. Appreciation is also extended to the academic community of Universitas Pancasakti Bekasi, the expert validators, and the teachers and staff of Denpasar Children Center Kindergarten for their contributions to this research. Special thanks are conveyed to the author's family for their continuous encouragement and support.

REFERENCES

Agustia, I., & Fitriani, D. (2025). Inovasi buku aktivitas "Magic Numbering" sebagai media penguatan kemampuan numerasi anak usia dini. Jurnal Caksana: Pendidikan Anak Usia Dini, 8(2), 1631–1646. https://doi.org/10.31326/jcpaud.v8i2.2590.

Ambayati, H., Handayani, A., Dwijayanti, I., Supiani, & Nurfitriah. (2025). Pengembangan media apron hitung untuk meningkatkan kemampuan berhitung anak usia dini 5–6 tahun dengan pendekatan ADDIE. Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 9(6), 3178–3190. https://doi.org/10.31004/obsesi.v9i6.7374.

Budiarti, E. (2025). Enhancing early childhood mathematics learning through interactive educational technology: A case study of digital batik. Assyfa Learning Journal, 3(1), 23–42. https://doi.org/10.61650/alj.v3i1.184.

Burns, S., Saleem, S., McMullen, E., Falenchuk, O., White, L., Dhuey, E., & Perlman, M. (2025). A systematic review and meta-analysis of approaches to teaching problem-solving skills in early childhood education and care settings: A focus on science, technology, engineering and mathematics activities. Review of Education, 13(2), e70079. https://doi.org/10.1002/rev3.70079.

Gracia, A. R. K., & Watini, S. (2022). Peningkatan Kognitif melalui Literasi Numerik dan Saintifik dengan Metode Atik pada Kegiatan Cat Air di TK Mutiara Lebah. JIIP - Jurnal Ilmiah Ilmu Pendidikan, 5(2), 628–632. https://doi.org/10.54371/jiip.v5i2.467.

Haryati, S. (2012). Research and development (R&D) sebagai salah satu model penelitian dalam bidang pendidikan. Majalah Ilmiah Dinamika, 37(1), 11–26.

National Association for the Education of Young Children, & National Council of Teachers of Mathematics. (2010). Early childhood mathematics: Promoting good beginnings. NAEYC.

National Association for the Education of Young Children. (2020). Developmentally appropriate practice (DAP) position statement. NAEYC.

Organisation for Economic Co-operation and Development. (2023). PISA 2022 results: The state of learning and equity in education. OECD Publishing.

Piaget, J. (1964). Development and learning. In R. E. Ripple & V. N. Rockcastle (Eds.), Piaget rediscovered: A report of the conference on cognitive studies and curriculum development. Cornell University.

Purba, N., Wondal, R., Yuliantina, I., Sagala, A. C. D., Budiarti, E., Susanti, D., & Herman, H. (2026). Bringing Numbers to Life through Numeracy Literacy: Practical Use of E-Comic Media in Early Education. Studies in Media and Communication, 14(1), 15–25. https://doi.org/10.11114/smc.v14i1.7933.

Purpura, D. J., & Lonigan, C. J. (2015). Early numeracy assessment: The development of the Preschool Early Numeracy Scales. Early Childhood Research Quarterly, 31, 1–15.

Saqinah, F., & Yuliantina, I. (2024). Pengaruh Pembelajaran Berbasis Projek dengan Buku Aktifitas Interaktif terhadap Kemampuan Literasi dan Numerasi. JIIP - Jurnal Ilmiah Ilmu Pendidikan, 7(12), 14281–14287. https://doi.org/10.54371/jiip.v7i12.6495.

Sugiyono. (2009). Metode penelitian kuantitatif, kualitatif dan R&D. Alfabeta.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Waruwu, M. (2024). Metode penelitian dan pengembangan (R&D): Konsep, jenis, tahapan dan kelebihan. Jurnal Ilmiah Profesi Pendidikan, 9(2), 1220–1230. https://doi.org/10.29303/jipp.v9i2.2141.

Wortham, S. C. (2018). Assessment in early childhood education. Pearson.