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Development of a Parent Training Module for Designing Adaptive Individualized Numeracy Learning Programs for Children Aged 5–6 Years

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A B S T R A C T

This study developed and evaluated an Adaptive Individualized Numeracy Learning Program training module for parents of children aged 5–6 years. A needs analysis involving focus group discussions and open-ended questionnaires revealed parents' limited understanding of multidimensional numeracy concepts and individualized learning strategies, as well as the absence of structured guidance for home-based support. Using the ADDIE framework, the module was systematically designed, validated by experts, and implemented through small- and large-group trials. Findings indicated that the module met high standards of content and language feasibility and was practically applicable in home learning contexts. Effectiveness testing demonstrated a significant improvement in parents' knowledge and readiness to design adaptive numeracy activities, with a very large effect size. Qualitative findings further showed enhanced parental confidence, improved ability to align activities with children's developmental levels, and increased use of play-based strategies in daily routines. Overall, the module is pedagogically feasible and effective in strengthening parents' capacity to support individualized early numeracy development at home.

1. Introduction

Numeracy development in early childhood constitutes a foundational dimension of cognitive growth and a strong predictor of later academic achievement. Numeracy encompasses not only counting skills, but also the ability to reason with numbers, identify patterns, interpret data, measure quantities, and apply mathematical ideas in everyday contexts. In this sense, early numeracy competence contributes to children's problem-solving capacity, logical reasoning, and readiness for subsequent learning (Wardhani et al., 2021; Friantini et al., 2021). Strengthening

numeracy learning during the preschool years, particularly for children aged 5–6 years, is therefore essential, as this period represents a critical stage for cognitive stimulation and concept formation.

Despite its significance, numeracy achievement in Indonesia remains a concern. International and national assessments show that students continue to struggle with core numeracy competencies, particularly reasoning, measurement, and data interpretation. PISA evidence further indicates that students perform better on procedural tasks than on those requiring reasoning and contextual interpretation of quantitative information (OECD, 2023). This suggests that numeracy instruction has not fully promoted deeper understanding or real-life application of mathematical concepts. One possible explanation is the persistence of uniform instructional approaches that do not adequately address individual learner differences. Children enter early childhood education with varied prior knowledge, pace, interests, and home learning experiences. Such mismatches may hinder optimal cognitive development (Salminen et al., 2021), making adaptive and individualized approaches increasingly important in early childhood education.

Within this context, parents occupy a crucial role because the family is the earliest and most consistent environment for children's learning. As children's first facilitators, parents strongly influence early development. Parental involvement in home-based learning activities has been shown to support literacy and numeracy development (Melhuish et al., 2008; Davis-Kean, 2005). However, many parents still face difficulties in supporting numeracy at home. Parenting information from social media is often fragmented and inconsistent, making it difficult to identify effective and developmentally appropriate strategies. Consequently, numeracy is often understood narrowly as counting or number recognition rather than as a multidimensional construct.

Preliminary needs analysis conducted through focus group discussions and open-ended questionnaires with parents of children aged 5–6 years revealed several related issues. Many parents demonstrated limited understanding of numeracy as a comprehensive developmental skill and lacked awareness of age-appropriate milestones. They were also unfamiliar with adaptive or individualized learning approaches and had minimal structured guidance for facilitating numeracy at home. In addition, they reported practical constraints, including limited time, restricted instructional strategies, and declining child motivation. At the same time, parents expressed a strong willingness to support their children's learning when provided with clear, practical, and applicable guidance.

One pedagogical approach with the potential to address these challenges is the Individualized Learning Program, commonly known as the Individualized Education Program (IEP). Traditionally, IEPs are designed to support children with special educational needs through systematic assessment, individualized goal setting, tailored instructional strategies, and continuous evaluation (Jaya et al., 2018; Cleveland & Markham, 2024). Their key principles include learner-centeredness, flexibility, collaboration with parents, and responsiveness to children's developmental progress. Although originally developed within special

education, research suggests that the principles of individualized learning may also benefit typically developing children when implemented adaptively (Odom & Wolery, 2003; J. M. Byford et al., 2025).

The application of individualized learning principles to early childhood numeracy offers several advantages. Individualized planning enables learning experiences to be aligned with children's abilities, interests, and developmental pace, thereby enhancing engagement and instructional effectiveness. Moreover, individualized approaches emphasize formative assessment and reflective practice, allowing ongoing adjustments based on children's responses and progress. In home-based settings, these principles may assist parents in transforming everyday routines into meaningful, play-based numeracy experiences that are relevant to children's lives and developmental needs.

However, effective parental implementation of individualized learning requires adequate training and structured support. Research indicates that parental involvement becomes more effective when parents possess sufficient knowledge, skills, and confidence to facilitate learning activities (S. Byford et al., 2015). Without clear guidance, parents may find it difficult to design appropriate activities, establish realistic goals, and monitor progress in a systematic manner. Therefore, parent training programs that are practical, accessible, and grounded in authentic family contexts are needed to bridge the gap between theoretical principles and everyday educational practice.

Existing studies on individualized learning programs have mainly focused on professional educators working with children with special needs in school settings (Pretti-Frontczak & Bricker, 2000; Şahin et al., 2023). Limited attention has been given to empowering parents of typically developing children through structured training modules, particularly in early numeracy. In addition, many studies treat home numeracy as a single construct, without distinguishing number sense, early algebra, geometry, measurement, and data analysis. This limited specificity may partly explain inconsistent findings on children's outcomes (Leyva et al., 2021). Recent development studies in the Journal of Educational Sciences also show growing interest in instructional module design using systematic development models (A. I. Putri & Anggraini, 2025), but still focus mainly on classroom implementation and student outcomes alone.

In response to these gaps, this study develops an Adaptive Individualized Numeracy Learning Program training module for parents of children aged 5–6 years. The module applies individualized learning principles that are adapted to the characteristics of typically developing children and to home learning contexts. It offers structured guidance for parents to identify children's numeracy strengths and needs, formulate individualized goals, design play-based learning activities across major numeracy domains including numbers, early algebra, geometry and measurement, and data analysis, and reflect on the learning process.

The novelty of this study lies in three aspects. First, it extends individualized learning principles beyond special education into early childhood numeracy for

typically developing children. Second, it positions parents as agents of individualized learning through a training module. Third, it adopts a comprehensive view of numeracy that emphasizes reasoning, problem solving, and real-life application rather than procedural skills alone. Accordingly, this study aims to develop an Adaptive Individualized Numeracy Learning Program training module using the ADDIE model and examine its effectiveness in improving parents' knowledge and skills in facilitating individualized numeracy learning at home.

2. Methodology

Research Design

This study employed a Research and Development (R&D) approach using a mixed-methods design, integrating qualitative and quantitative data to develop and evaluate an Adaptive Individualized Numeracy Learning Program training module for parents of children aged 5–6 years. The development process followed the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which provides a systematic and flexible framework for instructional product development (Branch, 2010). The ADDIE model was selected because it emphasizes learner-centered design, iterative refinement, and continuous evaluation, making it suitable for developing parent-oriented training modules in early childhood education contexts.

Research Setting and Participants

The study was conducted in September 2025 at two Islamic kindergartens: TKIT Vidya Nur Iman (South Jakarta) and TKIT Juara (South Tangerang). These sites were selected purposively due to their prior collaboration with the researcher and their openness to parent-based educational interventions. Participants were parents of children aged 5–6 years enrolled in the two kindergartens. Sampling was conducted using purposive sampling, as the study specifically targeted parents who were actively involved in their children's daily learning activities at home. The research participants were involved in different stages of the study:

a. Needs analysis stage: 11 parents participated in focus group discussions (FGDs) and open-ended questionnaires.
b. Small-group trial: 15 parents participated in the initial implementation of the module.
c. Large-group trial: 36 parents participated in the field trial to examine the effectiveness of the module.
d. In-depth interviews: 5 parents were selected purposively from the large-group trial to explore their experiences in implementing the program at home.

Development Procedure

The development of this training module followed the ADDIE instructional design model, which consists of five systematic and interrelated phases: Analysis, Design,

Development, Implementation, and Evaluation. The model was selected because it provides a structured yet flexible framework for developing educational products grounded in learner needs and iterative refinement. Each phase plays a distinct role, beginning with identifying contextual needs, followed by designing instructional components, developing and validating the prototype, implementing the module in real settings, and conducting evaluation to assess feasibility and effectiveness. The overall development flow of the module based on the ADDIE model is illustrated in Figure 1 below.

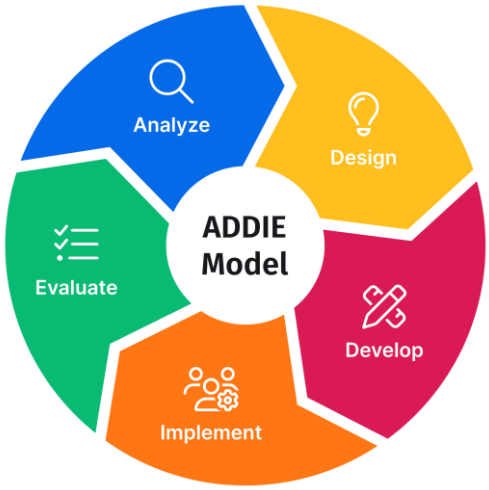

Figure 1. ADDIE Model

a. Analysis Phase

The analysis phase aimed to identify parents' needs, prior knowledge, challenges, and expectations related to early childhood numeracy and individualized learning. Data were collected through FGDs and open-ended questionnaires involving 11 parents. The findings revealed limited parental understanding of numeracy as a multidimensional construct, unfamiliarity with individualized learning programs, difficulties in maintaining children's motivation, and the absence of a structured guide for home-based numeracy stimulation. These findings served as the foundation for designing the training module. Conducting a needs analysis prior to module development is consistent with previous development research emphasizing user-based design principles (E. K. Putri et al., 2023), ensuring that instructional products are grounded in contextual demands and learner characteristics.

b. Design Phase

Based on the needs analysis, the module was designed to help parents develop individualized numeracy programs tailored to their children's abilities and interests. The module structure included:

1) an introduction to early childhood numeracy concepts and developmental milestones;
2) principles of adaptive individualized learning;
3) step-by-step guidance for designing individualized numeracy goals;

4) play-based numeracy activities covering numbers, early algebra, geometry, measurement, and data analysis; and
5) reflection and evaluation guidelines.

c. Development Phase
In the development phase, a prototype of the training module was produced and subjected to expert validation. Content validation was conducted by five validators, including two educational experts, one early childhood numeracy expert, and two parent representatives. The validation focused on content relevance, clarity, accuracy, language use, and practicality. Revisions were made based on validators' feedback to improve the quality and usability of the module.

d. Implementation Phase
The revised module was implemented through parent training sessions conducted in two stages: a small-group trial and a large-group trial. Parents were guided to identify their children's numeracy needs, formulate individualized goals, select appropriate activities, and prepare simple learning materials. Parents were encouraged to implement the individualized numeracy program at home using play-based and daily-life contexts.

e. Evaluation Phase
Evaluation was conducted to examine the feasibility and effectiveness of the module. The small-group trial focused on obtaining feedback for refinement, while the large-group trial assessed changes in parents' knowledge, readiness, and skills before and after the training.

Instruments and Data Collection

The pretest–posttest questionnaire consisted of 25 items distributed across five domains: (B1) understanding of early numeracy concepts, (B2) knowledge of individualized learning principles, (B3) ability to formulate individualized goals, (B4) skill in designing play-based numeracy activities, and (B5) readiness to evaluate and reflect on implementation. Each domain contained five items measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Content validity was examined through expert judgment involving five validators. The average content validity index indicated that all items were considered relevant and appropriate. Reliability analysis from the large-group trial demonstrated satisfactory internal consistency (Cronbach's alpha > 0.80), indicating that the instrument was reliable for measuring parental knowledge and readiness. Data were collected using multiple instruments to ensure triangulation:

a. FGD and open-ended questionnaires were used during the needs analysis stage to explore parents' perceptions, experiences, and expectations.
b. Expert validation sheets assessed the content and language quality of the module using a Likert-scale format.
c. Pretest and posttest questionnaires measured parents' knowledge of early childhood numeracy, understanding of individualized learning programs, readiness, and self-reported skills in designing numeracy activities.

d. Semi-structured interview guidelines were used to collect qualitative data from parents who implemented the program at home.

Data Analysis

Qualitative data from FGDs, open-ended questionnaires, and interviews were analyzed using thematic analysis, following the procedures of data transcription, data reduction, categorization, and interpretation (Miles et al., 2014). Coding was conducted to identify recurring themes related to parental understanding, implementation experiences, challenges, and perceived benefits of the module. Quantitative data from expert validation and pretest–posttest questionnaires were analyzed using descriptive statistics to determine the feasibility of the module. To examine the effectiveness of the training, a paired sample t-test was conducted using SPSS 26.0 to compare parents' pretest and posttest scores. Statistical significance was determined at $p < 0.05$. Effect size was calculated using Cohen's d to determine the magnitude of the training effect.

Ethical Considerations

All participants provided informed consent prior to data collection. Participation was voluntary, and confidentiality of participants' identities and responses was ensured throughout the research process. Within the ADDIE framework, the evaluation phase was directly linked to effectiveness testing. The formative evaluation occurred during expert validation and the small-group trial, while the summative evaluation was conducted through the large-group pretest–posttest design. This integration ensured that the effectiveness findings were not merely procedural outcomes but reflected systematic refinement across development stages.

3. Results and Discussion

This section presents the key findings on the quality and performance of the developed training module for parents to design an Individualized Adaptive Numeracy Learning Program for children aged 5–6 years.

Expert Validation of the Module

Expert review indicated that the module met the expected quality standard across three dimensions: content feasibility, language feasibility, and the quality of evaluation items. Table 1 summarizes the validation outcomes. Overall, each dimension achieved a "very good" rating, suggesting that the module is ready for user trials with only minor revisions.

Table 1. Expert Validation Summary of the Module

Aspect	Mean score	Category
Content feasibility	4.30	Very good
Language feasibility	4.58	Very good

Evaluation items (test) quality	4.56	Very good
Instructional Aligment	4.56	Very good

To provide a quick visual overview, Figure 2 presents the mean validation scores for each dimension. The language dimension obtained the highest mean score, indicating that the module's wording and readability are particularly strong.

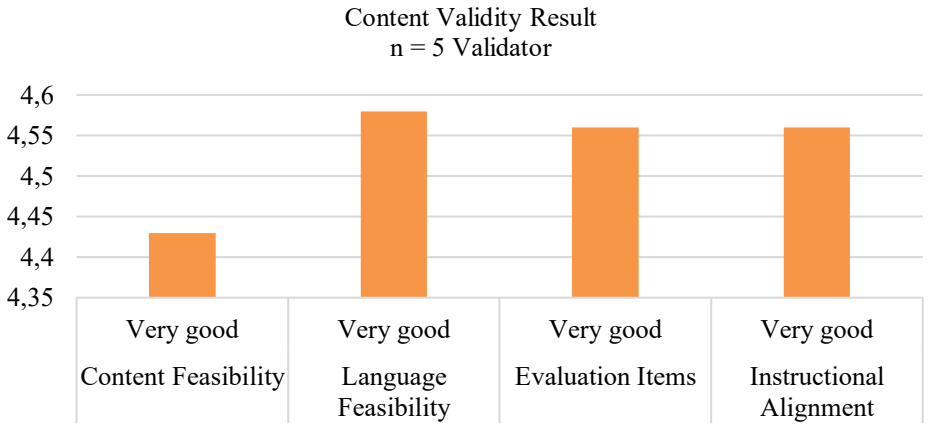

Figure 2. Mean Scores from Expert Validation

Practicality in User Trials

Practicality was examined through a small-group trial (15 parents) and a larger field trial (36 parents). As shown in Table 2, the module was rated "good" in both trials, with the large-group trial showing a higher overall mean rating. These results suggest that the module is not only feasible but also user-friendly and applicable in varied parent backgrounds.

Table 2. Practicality Ratings from Small-Group and Large-Group Trials

Trial	N	Mean rating	Category
Small group	15	3.96	Good
Large group	36	4.20	Good

The small-group trial highlighted the module's layout and visual supports as particularly helpful, while the large-group trial emphasized the relevance of the content to parents' daily practice. This pattern is consistent with a design that prioritizes step-by-step guidance, examples, and practical activities that can be implemented at home. The positive practicality ratings align with prior findings that usability and user experience significantly influence the acceptance and effectiveness of instructional modules (Abdurrahman, 2025).

Effectiveness of the Module Implementation

The significant improvement observed in this study is consistent with previous module development research demonstrating that structured instructional materials contribute to measurable learning gains (Rosiana et al., 2023; Munatayeva et al.,

2025). Similar to these studies, the present module integrates systematic planning, formative validation, and structured implementation, which may explain the magnitude of improvement. Effectiveness was evaluated using a pretest–posttest design. Normality checks supported the use of paired-samples t-tests. Table 3 reports descriptive statistics and inferential results for each domain (B1–B5) and the total score. All domains showed statistically significant improvements ($p < 0.001$), indicating that parents' understanding increased after participating in the training supported by the module.

Table 3. Pretest–Posttest Results (Descriptive and Paired t-test)

Domain	Pre (M)	Post (M)	Mean diff (Post−Pre)	t(df)	p	Cohen's d
B1	20.22	27.44	7.22	10.851 (35)	<0.001	1.81
B2	14.83	22.72	7.89	16.808 (35)	<0.001	2.80
B3	13.61	19.06	5.44	12.452 (35)	<0.001	2.08
B4	15.44	22.17	6.72	12.769 (35)	<0.001	2.13
B5	17.19	22.36	5.17	9.961 (35)	<0.001	1.66
Total	81.31	113.75	32.44	16.260 (35)	<0.001	2.71

Note: Effect size is reported as Cohen's d for paired samples following Cohen (1988).

Figure 3 provides a visual comparison of pretest and posttest mean scores. The largest absolute gain was observed in the total score (an increase of 32.44 points), which corresponds to a very large paired effect size (Cohen's d (Cohen, 1988) ≈ 2.71) (Cohen et al., 2018). Such a magnitude suggests that the intervention produced a strong and practically meaningful change in parents' knowledge and skills relevant to individualized numeracy support.

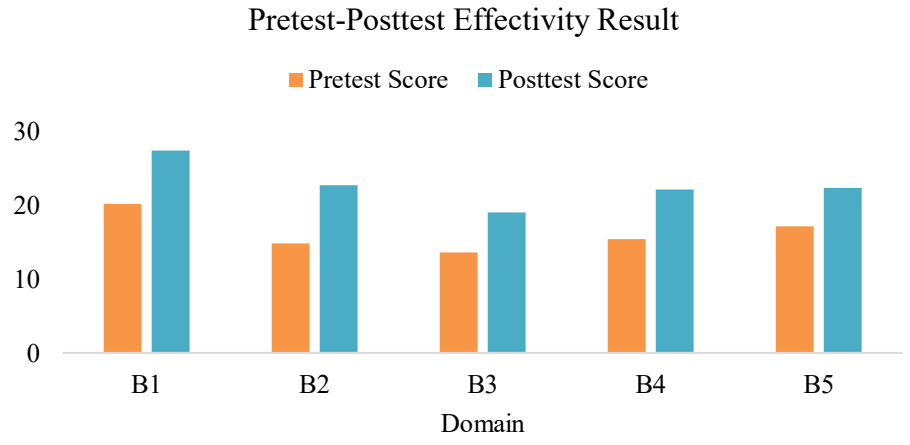

Figure 3. Mean Pretest and Posttest Scores by Domain and Total

Discussion and Implications

Theoretically, this study extends the application of individualized learning principles beyond special education settings by positioning parents as active designers of adaptive learning plans. It contributes to early numeracy literature by integrating individualized planning with multidimensional numeracy domains, thereby offering a structured model for home-based differentiation. The results indicate that the module is valid, practical, and effective for its intended users: parents of children aged 5–6 years. High expert ratings on content, language, and evaluation items suggest alignment with core requirements of individualized program design, namely being assessment-informed, goal-oriented, and clearly documented (Jaya et al., 2018;Cleveland & Markham, 2024).This alignment is important because an individualized program is expected to translate a child profile into measurable goals, planned activities, and monitoring procedures that can be implemented consistently at home and, where possible, coordinated with educators (Solberg et al., 2014;Kangas & Cioè-Peña, 2024).

From a home-learning perspective, the module's practicality and the observed learning gains support the idea that strengthening parental knowledge and confidence can improve the quality of learning support provided in everyday settings. Prior studies show that the home learning environment and parental involvement are associated with children's literacy and numeracy development (Melhuish et al., 2008), and longitudinal evidence highlights the role of the home context for early numeracy and literacy growth (Salminen et al., 2021). However, implementation is not without barriers; limited time and fluctuating child attention are common challenges in home learning, underscoring the need for flexible guidance and realistic pacing (Rizhan et al., 2024;Vicente & Revilla, 2022).

The pattern of improvements across domains suggests that parents' understanding of numeracy expanded beyond counting to include broader subdomains such as patterns, measurement, and data-related reasoning. This is consistent with the conceptualization that numeracy in early childhood involves applying numbers and symbols in daily contexts, recognizing patterns and relationships, and using them for problem solving (Wardhani et al., 2021). The domain structure used in the module also resonates with broader descriptions of early numeracy scope, which includes early number sense, mathematical reasoning, geometry/patterns, and foundational algebraic thinking (Gorman et al., 2023; Clements & Sarama, 2014). Therefore, the module's domain-based planning can help parents match activities with children's developmental milestones in a more targeted way (Carruthers & Worthington, 2023; Harris & Petersen, 2019).

Qualitative findings further support the quantitative improvements by showing that parents experienced clearer understanding of children's strengths and needs, implemented contextual play-based activities, and benefited from teacher input and family support. Such findings align with the view that effective individualized learning is strengthened by collaboration between families and schools and by practices that recognize family strengths and contexts (Dunst & Espe-Sherwindt, 2016; Putro et al., 2020). Structured parent training is also widely highlighted as a

mechanism that improves parents' ability to support child development (S. Byford et al., 2015). In this study, parents reported that contextual and enjoyable activities increased children's motivation and confidence, which is consistent with evidence that meaningful learning experiences can enhance motivation and engagement (Sari et al., 2025; Arfiani, 2024) and that a positive numeracy environment supports foundational skills (Rosyadi & Pd, 2024). Taken together, the module appears to function as an actionable guide for parents to plan, enact, and adapt numeracy learning activities at home based on children's readiness and interests, while maintaining coherence with individualized program principles (Cleveland & Markham, 2024).

Practically, the module offers a replicable framework for schools seeking to strengthen home-school collaboration. Early childhood institutions may adapt this model to design parent workshops that align individualized planning with curriculum goals. This study has several limitations. The sample was limited to two Islamic kindergartens in urban areas, which may restrict generalizability. The effectiveness evaluation focused on parental knowledge and self-reported skills rather than direct measurement of children's numeracy outcomes. Future studies should incorporate standardized child assessments and longitudinal designs to examine sustained impact. For wider application, future work may test the module across more diverse parent backgrounds and school contexts and examine sustainability over longer periods, including whether parents maintain individualized planning practices and how these practices relate to children's numeracy outcomes over time (Melhuish et al., 2008).

4. Conclusion

This study aimed to develop and evaluate an Adaptive Individualized Numeracy Learning Program training module for parents of children aged 5–6 years using the ADDIE development model. The findings demonstrate that the module met established standards of content validity and practicality and was effective in enhancing parents' knowledge, readiness, and confidence in designing individualized numeracy activities at home. The structured training approach enabled parents to better understand multidimensional numeracy domains and to translate individualized planning principles into contextual, play-based learning practices. Overall, the study indicates that the development of a parent-centered adaptive module was successful in strengthening home-based numeracy support. The integration of needs analysis, expert validation, iterative refinement, and effectiveness evaluation ensured that the module was not only theoretically grounded but also practically applicable. These results suggest that structured parent training can serve as a viable strategy to promote adaptive learning practices in early childhood education. Future research may explore broader implementation contexts and examine long-term impacts on children's numeracy development.

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