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Developing Digital Animated Learning Media (DIMAS) to Introduce Number Concepts in Early Childhood

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Abstract

Recognizing number concepts is a fundamental numeracy competency that should be developed during early childhood. Initial observations at TK Attamim indicated that 4–5-year-old children's number-concept abilities were not yet optimal and that classroom learning relied heavily on conventional media. This study aimed to develop and assess the feasibility of Digital Animation (DIMAS) learning media and to examine changes in children's number-concept scores following its implementation. The study employed a Research and Development (R&D) approach using the ADDIE model and involved 15 children in Group A. Validation by a media expert, a material expert, and an early childhood education practitioner yielded an average feasibility score of 95.33%, categorized as very feasible. The field implementation was conducted over five meetings, approximately 30–40 minutes per meeting. The mean score increased from 46.00 (SD = 7.37) on the pretest to 75.67 (SD = 7.99) on the posttest. A paired-samples t-test indicated a statistically significant difference, $t(14) = 38.71$, $p < 0.001$, with a 95% confidence interval for the mean difference of 28.02–31.31 points. Because the distribution of paired differences departed from normality, a Wilcoxon signed-rank sensitivity check was also conducted and remained statistically significant ($W = 0$, $p = 0.0004$). The mean N-Gain was 0.56, categorized as moderate,. These results indicate an observed improvement in children's number-concept scores following implementation of DIMAS. Because the study used a one-group pretest-posttest design without a comparison group, the observed improvement should not be interpreted as conclusive evidence of a causal effect of the media.

Keywords: digital animation; early childhood; learning media; number concepts; numeracy skills

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1. Introduction

Number concepts constitute a fundamental foundation for developing children's early numeracy skills. A strong understanding of number concepts enables children to develop systematic counting, reasoning, and problem-solving abilities that support subsequent mathematical learning. In early childhood, these abilities are developed gradually through concrete, meaningful, and developmentally appropriate experiences. Therefore, early childhood education plays a strategic role in providing stimulation that helps children connect numerical symbols with quantities and everyday experiences (Lestari & Khadijah, 2023; Papadakis et al., 2021).

In response, the Indonesian government has made efforts to strengthen numeracy through curriculum reform, particularly through the *Kurikulum Merdeka*, which emphasizes essential competencies and supports the integration of digital learning resources(Agustina et al., 2024; Kemendikbudristek, 2023; Supriyanto & Wibowo, 2024). Despite these macro-level efforts, implementation at the classroom level may still face challenges related to disparities in educational quality, teacher readiness, and access to innovative learning resources (Lubis & Yetti, 2022; Rahayu & Puspita, 2022). This issue was also observed at TK Attamim, where the ability of children aged 4–5 years in Group A to recognize number concepts was still limited. Most children were able to recite number sequences verbally but had difficulty demonstrating their understanding of corresponding quantities. They experienced difficulties when matching quantities of concrete objects with their corresponding number symbols, suggesting that their understanding of numbers was not yet fully connected to quantity concepts. Classroom learning also relied heavily on conventional media,

including teacher explanations, printed number cards, and worksheets, providing limited opportunities for children to engage with numerical concepts through varied and interactive experiences.

In the modern digital era, early childhood learning strategies increasingly need to consider children's experiences with digital technology and the potential of digital media to support developmentally appropriate learning (Astuti & Iriyanto, 2023; Kucirkova & Cremin, 2021; Wulandari & Purwanto, 2023). Relying solely on conventional media is no longer effective for maintaining the short attention spans of 4–5-year-old children From a cognitive development perspective, children in the preoperational stage benefit from concrete, visual, and meaningful representations when learning abstract concepts (Mayer & Fiorella, 2022). Digital learning media, particularly educational animation, can therefore provide a means of representing numerical concepts through dynamic visual and contextual presentations (Neumann & Neumann, 2022; Purpura et al., 2021). However, digital media should not be viewed as a substitute for teacher interaction. Its implementation needs to be developmentally appropriate, purposeful, and accompanied by teacher mediation to support children's active engagement and prevent passive screen use (Madigan et al., 2021; Wijaya & Suryana, 2024).

Recent literature also indicates growing interest in the use of multimedia technology to support early mathematics learning. A systematic literature review by Kartika et al. (2025) reported that multimedia and animated-video-based learning have potential to support children's mathematical learning and foundational numeracy. Similarly, Noviarini et al. (2025) reported positive classroom experiences associated with the use of multimedia technology, including educational videos, in supporting children's engagement and understanding of numerical concepts. At the same time, these studies also point to practical considerations, including teachers' digital literacy and access to appropriate technological resources. These findings suggest that the educational value of digital media depends not only on the presence of technology but also on how the media is designed and integrated into classroom learning.

Research focusing more specifically on early childhood numeracy has also reported positive findings regarding the use of digital and animated learning media. Sari et al. (2024) found that animated video media was associated with improvements in the early numeracy skills of children aged 5–6 years in a quasi-experimental study. Similarly, Daryati (2025) likewise reported positive outcomes from the use of interactive learning media in supporting children's basic numeracy skills. These findings indicate that visual and interactive media may help children engage with mathematical concepts that are otherwise abstract. However, the effectiveness of such media remains dependent on the suitability of the content, the developmental characteristics of the learners, and the way teachers facilitate its use in classroom activities.

Beyond numerical recognition, digital media may also provide opportunities to support children's engagement during learning activities. Endrawati (2024) reported positive classroom responses to the use of animated video media, including children's attention and learning motivation during activities. Similarly, Nurlaila & Rocmah (2024), reported improvements in children's initial numeracy skills following the systematic use of animated arithmetic media in classroom activities. The use of contextual and culturally relevant content has also been identified as a potential approach for making mathematical concepts more meaningful to young children, Altindağ Kumaş (2024) for example, examined digital storytelling in early mathematics and highlighted its potential as a learning approach. These findings collectively indicate that digital media can be designed not merely to present information but also to provide contextual and engaging learning experiences for young children.

Although previous studies have provided evidence regarding the potential of animated and digital media for supporting early numeracy, a research gap remains in the development of digital learning products that are systematically designed from classroom needs and followed through a structured Research and Development (R&D) process. Many previous studies have focused on the implementation or effectiveness of existing digital media, while fewer studies have described the development of a

complete animation product specifically designed around the needs of a particular early childhood classroom. The present study addresses this gap through the development of Digital Animation (DIMAS), a digital learning medium designed for children aged 4–5 years. DIMAS uses a continuous storyline featuring the characters Dimas and Kiko within a contextual zoo setting. Its learning sequence moves from counting concrete objects toward recognizing number symbols from 1 to 10, with interactive educational activities incorporated into the media to support teacher-guided learning.

Based on the identified educational problem and research gap, this study aims to develop and evaluate the DIMAS learning media for introducing number concepts to children aged 4–5 years at TK Attamim. Specifically, the study evaluates the feasibility of the product through assessments by media experts, material experts, and early childhood education practitioners. The study also examines changes in children's number-concept performance following the implementation of the developed media in classroom activities. Through this development process, the study seeks to provide a digital learning alternative that is developmentally appropriate, engaging, and relevant to classroom needs while supporting teachers in providing more interactive learning experiences for young children.

2. Methodology

This study used a Research and Development (R&D) approach with the ADDIE instructional design model: Analysis, Design, Development, Implementation, and Evaluation. Qualitative data were collected during needs analysis and classroom process observation, while quantitative data were used for product validation and pretest-posttest assessment. The field assessment used a one-group pretest-posttest design involving 15 children aged 4–5 years in Group A at TK Attamim, Perum Grand Kahuripan Cluster Singgalang, during the even semester of the 2025/2026 academic year. Participants were selected purposively based on the learning needs identified during preliminary observation.

The study was conducted under formal institutional permission (Surat Izin Penelitian) and was integrated into the regular classroom schedule. The implementation involved the teacher as the main classroom facilitator and the researcher as an observer. No individual identifying information about the children is reported in this manuscript.

Data collection comprised needs-analysis observation, a semi-structured interview with the classroom teacher, expert and practitioner validation questionnaires, process observation, and performance-based pretest and posttest assessment. The implementation was conducted over five meetings of approximately 30–40 minutes each. The pretest was administered before the implementation and the posttest after the implementation period. The media content covered number symbols 1–10 through animated presentation, guided interaction, and reinforcement activities. The exact classroom sequence followed the instructional plan documented in the research report.

The validation questionnaire used a 5-point Likert scale and was completed by three validators: a media expert, a material expert, and an early childhood education practitioner. The thesis identifies the validators as Dr. Leroy Holman Siahaan, M.Pd. (media), Fidha Fitriani, S.E., M.Pd. (material), and Nenden Angraini, M.Pd. (practitioner). The validation instrument assessed material suitability, presentation, language, visual design, and interactivity. Percentage scores were calculated against the maximum possible score and interpreted using the feasibility criteria applied in the study.

The effectiveness instrument consisted of 20 performance-based tasks covering recognition of number symbols, counting objects, matching quantities with symbols, determining quantities from symbols, ordering numbers, comparing quantities, and simple application of number concepts. Each task was scored on a 1–4 developmental rubric: 1 (Not Yet Developed), 2 (Starting to Develop), 3 (Developing as Expected), and 4 (Developing Very Well). The maximum raw score was 80 and was converted to a 0–100 scale for reporting. Tasks were administered individually by the teacher using

simple verbal instructions; children responded by naming, pointing, counting, matching, or ordering. The same assessment structure was used for the pretest and posttest.

Quantitative analysis included descriptive statistics, a Shapiro–Wilk test of the paired-score differences, a paired-samples t-test, mean N-Gain, and Cohen's dz. The N-Gain was calculated using the standard formula and categorized as low (<0.30), moderate (0.30–0.70), or high (>0.70), consistent with the categories used in the research report. Cohen's dz was calculated as the mean paired difference divided by the standard deviation of the paired differences. Because the paired differences were not normally distributed, a Wilcoxon signed-rank test was additionally used as a nonparametric sensitivity check. Qualitative observations were summarized descriptively to provide contextual information about implementation and were not treated as independent evidence of causal psychological outcomes.

The pretest and posttest data were processed using Jamovi version 2.7. The paired-samples t-test was reported as the parametric comparison, while the Wilcoxon signed-rank test was added as a sensitivity analysis because the paired differences did not meet the normality assumption. Statistical results were reported together with the mean difference and 95% confidence interval. Because the design did not include a comparison group, statistical significance was interpreted as evidence of a pretest-posttest difference within the participating group, not as proof of a causal effect attributable exclusively to DIMAS.

3. Results

The development process produced the Digital Animation (DIMAS) learning media titled "Mengenal Lambang Bilangan Bersama Dimas dan Kiko" (Recognizing Number Symbols with Dimas and Kiko). The final product was an HD MP4 animated video with a duration of 8 minutes 47 seconds and 18 scenes. The content was organized into an introduction, presentation of number symbols 1–10 using zoo-animal illustrations, conceptual review, interactive activities, and a closing section. The media combined animation, narration, illustrations, background music, sound effects, and guided pauses. The product was revised in response to validator feedback before classroom implementation.

Table 1
Recapitulation of Product Validation Results

Validator	Percentage (%)	Category
Media Expert	95.00	Very Feasible
Material Expert	95.00	Very Feasible
Practitioner (Teacher)	96.00	Very Feasible
Average	95.33	Very Feasible

Based on Table 1, the media expert awarded 95.00%, the material expert 95.00%, and the practitioner 96.00%. The overall mean was 95.33%, categorized as very feasible according to the study's feasibility criteria. Validator feedback was used for product revision before field implementation, including adjustment of background-music volume and extension of pauses during interactive activities.

The field implementation involved 15 children from Group A at TK Attamim. Children's number-concept performance was measured through a pretest before implementation and a posttest after implementation. Descriptive statistics are presented in Table 2.

Table 2
Descriptive Statistics of Pretest and Posttest Scores

Statistic	Pretest	Posttest
Sample Size (N)	15	15
Mean	46.00	75.67
Standard Deviation	7.37	7.99

Minimum Score	35	60
Maximum Score	60	90

The mean pretest score was 46.00 (SD = 7.37), while the mean posttest score was 75.67 (SD = 7.99), representing an absolute mean increase of 29.67 points. The minimum score increased from 35 to 60, and the maximum score increased from 60 to 90. These values correspond to the individual converted scores reported in the research dataset.

Inferential analysis was conducted to examine the pretest-posttest difference and the magnitude of the observed change. The results are summarized in Table 3.

Table 3
Descriptive Statistics of Pretest and Posttest Scores

Test / Measurement	Value	Interpretation
Shapiro–Wilk (paired differences)	W = 0.763; p = 0.001	Departure from normality
Paired-samples t-test	t(14) = 38.71; p < 0.001	Statistically significant difference
Wilcoxon signed-rank test	W = 0; p = 0.0004	Sensitivity check; statistically significant
Mean difference	29.67 points	Posttest higher than pretest
95% CI of mean difference	28.02–31.31	Estimated interval
Mean N-Gain	0.56	Moderate
Cohen's dz	10.00	Paired standardized difference; interpret cautiously

The Shapiro–Wilk test applied to the paired-score differences indicated a departure from normality (W = 0.763, p = 0.001). The paired-samples t-test nevertheless indicated a statistically significant pretest-posttest difference, t(14) = 38.71, p < 0.001, with a mean paired difference of 29.67 points and a 95% confidence interval of 28.02–31.31 points. Because the normality assumption for the paired differences was not met, a Wilcoxon signed-rank sensitivity check was also conducted and remained statistically significant (W = 0, p = 0.0004). The mean N-Gain was 0.56, categorized as moderate, and Cohen's dz was 10.00. These results indicate a substantial observed change in scores following implementation. Because the study did not include a comparison group, the change cannot be attributed exclusively to DIMAS.

4. Discussion

The field implementation was accompanied by an increase in children's number-concept scores from a mean of 46.00 on the pretest to 75.67 on the posttest. The paired-samples t-test indicated a statistically significant difference, t(14) = 38.71, p < 0.001, while the mean N-Gain was 0.56 (moderate). These findings show that the participating children performed better on the posttest than on the pretest after the implementation period. However, the one-group pretest-posttest design does not allow the observed change to be attributed solely to the media because repeated testing, maturation, classroom activities, and teacher involvement may also have contributed.

The design of DIMAS can be interpreted in relation to multimedia learning perspectives. The media combines number symbols with visual representations of quantities, narration, and guided pauses. This design is consistent with the general principle that coordinated verbal and visual information can support learning (Mayer, 2021). The present study, however, did not directly measure cognitive load, dual-channel processing, retention mechanisms, or other cognitive processes. Therefore,

the theoretical interpretation should be understood as an explanation of the product design rather than as experimental validation of those mechanisms.

The findings are also broadly consistent with previous empirical work on animated and digital learning media. Nurlaila and Rocmah (2023) reported improvement in initial numeracy skills after the use of animated arithmetic media, while Fatmawati et al. (2025) reported significant pretest-posttest improvement in symbolic-thinking ability following animated-video learning. Fitri et al. (2025) developed an animated mobile-learning medium for early numeracy, and Sari et al. (2024) reported positive findings for animated video in early numeracy learning. The present study extends this line of work by documenting the development and classroom implementation of a contextual animated product designed for a specific group of 4–5-year-old children. This pattern is also compatible with evidence from numerical-video training among preschoolers, although that study used a comparison-group design and therefore is not directly equivalent to the present study (Pellizzoni et al., 2024).

The learning sequence in DIMAS moves from visualized quantities and counting activities toward recognition and matching of number symbols. During implementation, the teacher also provided concrete follow-up activities, including number and picture cards, so that learning was not limited to passive viewing. Thus, the observed learning process involved the digital medium together with teacher-mediated activities.

Process observations indicated that children increasingly responded to questions, participated in counting activities, and completed matching or ordering tasks during the implementation. The teacher also reported that the structured sequence helped organize classroom activities. These observations provide contextual information about engagement and implementation; they should not be interpreted as quantitative evidence of increased attention span, self-confidence, motivation, or other psychological outcomes because those constructs were not measured with separate validated instruments.

Teacher mediation was an important component of the implementation. The video included pauses and interactive prompts, while the teacher could stop the video, ask children to count or discuss displayed objects, and provide reinforcement. The contribution of DIMAS should therefore be understood as part of a teacher-mediated learning activity rather than as a replacement for teacher interaction.

Overall, the findings support the feasibility of using a contextual animated video as one component of early number-concept learning at the study site. The evidence is strongest for product feasibility and for the observed pretest-posttest change within this specific group. It does not establish a causal mechanism or demonstrate general effectiveness across other early childhood settings.

Several limitations should be considered. First, the sample consisted of only 15 children from one institution, which limits generalizability. Second, the one-group pretest-posttest design did not include a comparison group, so alternative explanations such as maturation, repeated testing, classroom activities, and teacher involvement cannot be excluded. Third, the implementation period was relatively short. Future studies should use larger and more diverse samples, comparison groups or controlled designs, and repeated implementations to examine whether observed improvements are attributable specifically to the media and whether the findings generalize to other settings.

Ethical considerations: The study was conducted under formal institutional permission (Surat Izin Penelitian), and no individual identifying information about participating children is reported. The available research documentation does not specify a separate ethics-committee approval or a parental-consent procedure; therefore, this manuscript does not claim that such approval or procedure was obtained.

AI use disclosure: AI tools were used only as supportive instruments for language editing, manuscript organization, and consistency checking. All research data, statistical calculations, interpretations, and final manuscript decisions were reviewed and validated by the authors.

5. Conclusion

This study developed the Digital Animation (DIMAS) media for introducing number concepts to 4–5-year-old children at TK Attamim. Validation by a media expert, a material expert, and an early childhood education practitioner produced an average feasibility score of 95.33%, categorized as very feasible according to the study criteria. In the five-meeting classroom implementation, the mean score increased from 46.00 (SD = 7.37) on the pretest to 75.67 (SD = 7.99) on the posttest. The paired-samples t-test indicated a statistically significant difference, $t(14) = 38.71$, $p < 0.001$, and the Wilcoxon signed-rank sensitivity check was also significant ($W = 0$, $p = 0.0004$). The mean N-Gain was 0.56 (moderate), and Cohen's dz was 10.00. These results indicate an observed improvement in number-concept scores following implementation of DIMAS. Given the small sample and one-group pretest-posttest design, the findings should be interpreted as preliminary evidence of change rather than conclusive causal evidence of media effectiveness.

The contribution of the study is the development of a contextual animated learning medium tailored to the identified number-concept needs of 4–5-year-old children at TK Attamim. DIMAS integrates number symbols, quantities, animation, narration, interactive prompts, and teacher-guided pauses in a structured sequence. Future research should use comparison groups, larger and more diverse samples, and repeated implementations to determine the extent to which observed improvements are attributable specifically to the media and to examine the transferability of the findings.

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