The Effect of the 'Ocean Numbers' Interactive Multimedia on Early Numeracy in Young Children

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Abstract: Early numeracy skills are one of the fundamental foundations for children's future mathematical development. However, various studies show that early childhood numeracy skills in Indonesia are still relatively low, while teachers' instructional practices tend to be monotonous and lack the use of innovative media. This study aims to examine the effectiveness of the interactive multimedia *Ocean Numbers* in improving early numeracy skills of young children. This research employed a quantitative approach with a quasi-experimental design using a *One Group Pretest-Posttest Design*. The subjects were 27 children aged 5–6 years at TK Pembina Danau Kerinci, selected through purposive sampling. The research instrument was an early numeracy test that had undergone expert validation, empirical validity testing, and reliability testing, and was declared feasible for use. Data analysis included normality testing, paired sample t-test, and N-Gain analysis. The results indicated a significant difference between pretest and posttest scores, with the mean score increasing from 43.95 to 83.95 (sig. 0.000 < 0.05). The N-Gain score of 0.71 was categorized as high, indicating that the interactive multimedia *Ocean Numbers* was effective in enhancing children's early numeracy skills. Thus, this study strengthens the evidence that interactive multimedia can serve as an innovative and practical learning medium for early childhood teachers in facilitating engaging and meaningful numeracy learning.

1 INTRODUCTION

Early childhood refers to individuals from birth to six years of age. This period is often called the golden age because children experience very rapid development and it becomes a critical stage for their subsequent growth. If this period passes without appropriate stimulation, children may encounter difficulties, and in some cases, may no longer have the opportunity to achieve the developmental milestones expected during this stage (Santrock, 2019). Therefore, children at this age require proper stimulation to ensure optimal development, while also anticipating and addressing potential problems as early as possible.

Cognitive ability is one of the essential skills to be enhanced in the early years of a child's life because this period is critical for investing in the development of high-quality human resources (Pushparatnam et al., 2021). Cognitive development significantly influences the growth of other developmental domains in the child's life (Anida & Eliza, 2020). In developing this aspect, children can learn various concepts such as color, size, shape, direction, numbers, magnitude, and so on (Rakimahwati, 2014).

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One of the important skills in early childhood cognitive development is mathematical ability (National Research Council, 2009; Utoyo et al., 2025). Within mathematics, an area that needs to be developed is early numeracy. Early numeracy skills in young children are related to the ability to solve basic problems and apply mathematics in daily life. Early numeracy is not merely about counting numbers, but also encompasses the foundations of mathematical reasoning acquired from an early age (Wardhani et al., 2021).

Numeracy is one of the cognitive skills that should be developed (Rakimahwati, 2014). Meta-analysis findings show that early numeracy skills are predictors of children's future academic achievement (Duncan et al., 2007) These skills serve as the foundation for later learning and are considered one of the main goals of education (Hendrix et al., 2020). Numeracy activities before entering elementary school are crucial for the development of early numeracy in preschool-aged children (Reid & Andrews, 2016).

Early numeracy skills in preschool represent an early form of support that helps children develop before entering formal schooling(Reid & Andrews, 2016). Countries such as Australia, the United States, and the United Kingdom have even prioritized mathematics and numeracy skills development as part of their national education agenda through systemic initiatives(Wright et al., 2006). Considering the importance of early numeracy, young children need to possess adequate numeracy skills.

One of the effective ways to improve early numeracy skills is through the use of technology-based learning media. The rapid development of technology affects almost all aspects of life, including education. Technology can have positive effects on children's development if utilized appropriately, such as through the provision of educational content (Emi et al., 2024; Sulistyaningtyas et al., 2023)Today, many children prefer to play and learn using Android-based devices, requiring teachers and parents to anticipate this by providing suitable educational media. Early childhood teachers are expected to be capable of utilizing technology to provide learning media (Ferry Darmawan et al., 2024; Novaliendry et al., 2022). One of the media that can be used to enhance early numeracy skills is interactive multimedia.

Multimedia refers to the presentation of information using various forms such as text, sound, images, illustrations, animations, or videos (Mayer, 2014). This media can create realistic, interactive, and effective learning contexts, stimulate all children's senses, and allow learners to control their own learning processes.

Previous studies have shown that the application of interactive multimedia has a positive effect on early childhood numeracy (Fathimah & Ishartiwi, 2018; Makulua et al., 2024; Norita & Hadiyanto, 2021; Syarfina et al., 2023). It has been proven to improve numeracy skills of children aged 5–6 years. Moreover, interactive multimedia enables teachers to provide engaging and enjoyable numeracy learning tailored to children's developmental needs.

Observations conducted at TK Pembina Danau Kerinci indicated that several children aged 5–6 years had not yet mastered basic number concepts, the relationship between numbers and quantities, comparison of amounts, and simple addition and subtraction operations. The low level of early numeracy skills was suspected to be due to the limited use of instructional media, such as blackboards, worksheets, and simple tools. This situation made mathematics learning monotonous and less engaging for children. In fact, early childhood learning requires attractive media so that children do not become easily bored and are able to maintain concentration for longer periods (Zaini & Dewi, 2017).

Based on these problems, this study offers a solution through the use of the interactive multimedia "Ocean Numbers," a learning medium with an engaging design that suits children's characteristics. It is packaged with a sea animal theme and contains various numeracy activities aligned with the early childhood curriculum. This medium integrates animated materials, educational videos, and learning games designed to provide joyful learning experiences while stimulating early numeracy skills across different aspects. This study aims to examine the effect of the use of "Ocean Numbers" Interactive Multimedia on early numeracy skills in young children.

2 THEORETICAL REVIEWS

2.1 Early Childhood Cognitive Development

Cognitive development in children is the process through which they acquire, organize, and utilize knowledge. Piaget defines cognitive development as the progression of mental processes in the way children think. His theory of cognitive development stages even became the foundation of the "cognitive revolution," emphasizing the importance of mental activity in child development. According to Piaget,

cognitive development must be stimulated from infancy through motor activities (Papalia & Olds, 2011).

Furthermore, Piaget divides cognitive development into four stages. First, the sensorimotor stage (birth–2 years), where infants acquire knowledge of themselves and their environment through sensory experiences and motor activities. Second, the preoperational stage (2–7 years), when children understand the world through mental representations and symbolic thinking using images or signs. However, at this stage, they still face limitations such as egocentrism and centration. Third, the concrete operational stage (7–11 years), when children begin to think logically about concrete events, egocentrism decreases, and they are able to understand concepts of conservation and classification. Fourth, the formal operational stage (11 years and above), when children are capable of abstract, idealistic, and logical thinking (Santrock, 2019).

In addition to Piaget explain that cognitive development is one of the major distinctive aspects within the five periods of child development. First, in the prenatal stage (conception–birth), the fetus already demonstrates the ability to learn, remember, and respond to sensory stimuli. Second, infancy and toddlerhood (birth–3 years), when children begin to learn and remember, and by the end of the second year develop the ability to use symbols and solve problems. Third, early childhood (3–6 years), when children still think egocentrically, but memory and language develop rapidly, making intelligence more predictable. At this stage, preschool or kindergarten experiences provide essential stimulation for cognitive development. Fourth, middle childhood (6–11 years), when children begin to think logically about concrete events, egocentrism declines, and memory and language abilities increase, thereby supporting formal school learning. Fifth, adolescence (11–20 years), when individuals are able to think abstractly and use scientific reasoning, although some immature thinking may still be observed in certain individuals (Papalia & Olds, 2011).

Based on these explanations, it can be concluded that early childhood cognitive development falls within the preoperational stage according to Piaget. At this stage, children employ symbolic thinking and learn through representations of images or concrete objects. Therefore, stimulating cognitive development in early childhood should involve the use of learning media enriched with visual symbols, images, and concrete objects as tools to facilitate their thinking processes.

2.2 Early Numeracy Skills in Early Childhood

Etymologically, the term *early numeracy* comes from English, consisting of two words: *early*, meaning "beginning" or "early," and *numeracy*, meaning "counting." Thus, *early numeracy* can be interpreted as early counting skills in children.

According to Chan & Scalise (2022)early numeracy skills are informal abilities such as counting and comparing numerical magnitudes that children acquire before entering formal education. These skills have been proven to be an important predictor of children's later mathematical achievement. Early numeracy in young children is also closely related to basic problem-solving skills and the application of mathematical concepts in daily life. Adedoyin & Chisiyanwa (2018)emphasize that preschoolers' numeracy skills include number understanding, counting ability, solving number problems, measuring, ordering, recognizing patterns, as well as performing simple operations such as addition and subtraction.

In addition, early numeracy skills are one of the essential forms of stimulation provided in early childhood as the foundation for cognitive development and early learning contexts before entering formal schooling (Reid & Andrews, 2016). Numeracy is even considered one of the cognitive skills that must be developed from an early age (Rakimahwati, 2014).

A meta-analysis by Duncan et al. (2007)shows that early numeracy skills are a strong predictor of children's future academic performance. Therefore, it is crucial for children to develop a solid foundation of numeracy skills (Elliott et al., 2021). Numeracy activities in preschoolers are regarded as an important concept in developing early numeracy before they enter primary school (Reid & Andrews, 2016). Awareness of the importance of numeracy has even become an educational priority in many countries, such as Australia, the United States, and the United Kingdom, which have systematically implemented various initiatives to enhance early math and numeracy skills in young children (Wright et al., 2006).

Based on the above discussion, it can be concluded that early numeracy skills in young children encompass basic problem-solving abilities and the application of mathematics in everyday life. These skills are not only limited to counting numbers but also include the foundations of mathematical reasoning. Since they serve as a crucial predictor of future academic achievement, the development of

early numeracy skills from an early age is highly important.

2.3 Interactive Multimedia

Multimedia refers to the presentation of information through various forms of media, such as text, sound, images, illustrations, animations, and videos (Mayer, 2014) According to Liu (1996, p. 3), interactive multimedia can create a more realistic learning context, stimulate multiple senses, and provide effective learning experiences for children.

The main components of interactive multimedia include text, graphics, audio, video, and animation (Banerjee, 2019; Savov et al., 2019)However, not all elements must be incorporated into one program, at least two multimedia elements should be used, provided that their combination is complementary and does not confuse users. In this way, the learning message can be effectively conveyed.

Multimedia is one form of instructional media that is effective in increasing children's learning interest, as it can present learning materials in a more engaging, interactive, and easily understandable way (Miaz, Erwin, et al., 2019; Miaz, Helsa, et al., 2019).

In the context of this study, the interactive multimedia used is *Ocean Numbers*, which integrates animated learning materials, animated videos, and educational games. Animated videos have been proven to be enjoyable and capable of enhancing numeracy skills, as well as supporting children's cognitive development (Raudha et al., 2024; Sirait et al., 2023). Meanwhile, educational games allow children to learn through play (Kavak, 2022). The combination of these three elements makes *Ocean Numbers* an engaging, enjoyable, and effective learning medium for improving young children's early numeracy skills.

3 RESEARCH METHOD

This study employed a quantitative research approach with a quasi-experimental design. The design used was a One Group Pretest–Posttest Design, in which the research subjects were given a test before the treatment (pretest), then received treatment in the form of using the interactive multimedia *"Ocean Numbers"*, and afterward were given the same test again (posttest). This design was intended to determine the difference in early numeracy skills of young children before and after the treatment.

The research subjects were 27 children aged 5–6 years in Kindergarten B at TK Pembina Danau Kerinci. The sampling technique used was purposive sampling, with the following considerations: (1) children aged 5–6 years, (2) had not previously received learning through interactive multimedia, and (3) parents provided consent for their children to participate in the study.

The instrument used in this study was an early numeracy skills test for young children, codified from numeracy indicators developed by several experts. The instrument underwent expert validation to ensure content appropriateness with the construct being measured and was pilot-tested with young children to examine its empirical validity and reliability. The pilot test results indicated that the instrument possessed good validity and reliability, making it feasible to be used as a measurement tool in this study. This instrument is also in the process of being published in an accredited journal under the title *"Development of an Assessment Instrument for Early Numeracy Skills in Young Children"*, which has been accepted for publication in *Jurnal Pendidikan Anak Usia Dini Undiksha*, Vol. 13 No. 3 (2025), December edition.

Data analysis was carried out in several stages:

1. Normality Test, to ensure that the pretest and posttest data were normally distributed.
2. Hypothesis Testing, using the Paired Sample t-Test (if the data were normally distributed) to examine significant differences between pretest and posttest scores. If the data were not normally distributed, the Wilcoxon Signed Rank Test was applied.
3. N-Gain Test, to determine the level of improvement in children's numeracy skills from pretest to posttest and to measure the effectiveness of the interactive multimedia *"Ocean Numbers."*

The results of the analysis were used to determine whether the use of *"Ocean Numbers"* had a significant effect on the early numeracy skills of young children.

4 RESULTS AND DISCUSSION

4.1 Results

Data were analyzed using a normality test, paired sample t-test, and N-Gain test. The normality test aimed to ensure that the pretest and posttest data were normally distributed. The results of the normality test are presented in Table 1.

Table 1: Results of the Normality Test.

Test	Kolmogorov-Smirnov Sig.	Result
Pretest	0,200	Normal
Posttest	0,200	Normal

Based on Table 4.19, the significance value for the pretest was 0.200 > 0.05, and for the posttest was 0.200 > 0.05. Therefore, H_0 was accepted, indicating that the data were normally distributed. Consequently, the analysis was continued using the paired sample t-test.

Table 2: Results of the Paired Sample t-Test.

Test Pair	Mean Difference	t	df	Sig. (2-tailed)
Posttest-Pretest	40	22,638	26	,000

As shown in Table 2. the significance value (2-tailed) was 0.000 < 0.05, thus H_0 was rejected. This means that there was a significant difference between the pretest and posttest scores of early numeracy skills after the implementation of the interactive multimedia *Ocean Numbers*.

Descriptively, the pretest results showed that 22 children were in the "Beginning to Develop" (Mulai Berkembang/MB) category, and 5 children were in the "Developing as Expected" (Berkembang Sesuai Harapan/BSH) category, with an average score of 43.95. After the treatment, the posttest results indicated an improvement, with 18 children in the "Very Well Developed" (Berkembang Sangat Baik/BSB) category and 9 children in the "Developing as Expected" (BSH) category, with an average score of 83.95.

To measure the extent of the improvement, an N-Gain test was conducted. The calculation was as follows:

$$Ngain = \frac{(Mean\ Posttest\ Score) - (Mean\ Pretest\ Score)}{(Max\ Posttest\ Score) - (Mean\ Pretest\ Score)}$$

$$Ngain = \frac{(83{,}95) - (43{,}95)}{(100) - (43{,}95)}$$

$$Ngain = \frac{40}{56{,}05}$$

$$Ngain = 0{,}71$$

Based on the results, the N-Gain score was 0.71, which falls into the high category. This indicates that the use of interactive multimedia *Ocean Numbers* was effective in improving the early numeracy skills of young children.

4.2 Discussion

The findings of this study demonstrate that the interactive multimedia *Ocean Numbers* was effective in improving the early numeracy skills of young children. This result is consistent with previous studies which have confirmed that the use of interactive multimedia in learning has a positive impact on children's numeracy development (Fathimah & Ishartiwi, 2018; Makulua et al., 2024; Norita & Hadiyanto, 2021; Syarfina et al., 2023). Interactive multimedia significantly improved the numeracy skills of children aged 5–6 years. These findings highlight that interactive-based media can serve as an effective tool for teachers to deliver numeracy learning in ways that are more engaging, enjoyable, and aligned with children's developmental stages (Norita & Hadiyanto, 2021).

The strength of *Ocean Numbers* lies in its integration of animated materials, animated videos, and educational games into a single medium. Each component contributes specifically to the enhancement of numeracy skills. For instance, animated videos have been proven to create enjoyable learning environments while improving children's counting abilities and supporting cognitive development (Raudha et al., 2024; Sirait et al., 2023). Meanwhile, the gaming element allows children to learn through play (Hazizah et al., 2024; KAVAK, 2022; Suparman et al., 2024), fosters logical-mathematical intelligence (Rakimahwati et al., 2022), and strengthens skills in number recognition and problem-solving (Solfiah et al., 2021). The synergy of these three components makes *Ocean Numbers* not only an engaging and enjoyable learning medium but also an effective tool for supporting the development of children's early numeracy skills.

The effectiveness of *Ocean Numbers* can also be explained theoretically through the lens of early childhood cognitive development. According to Santrock (2019) young children are in the preoperational stage, where they think symbolically and learn through images or concrete objects. Therefore, mathematics learning at the early childhood level requires concrete media that utilize visual symbols to help children understand abstract concepts. *Ocean Numbers* addresses this need by presenting numeracy concepts through interactive visualizations grounded in children's everyday life contexts.

In conclusion, the results of this study strengthen the evidence that interactive multimedia not only significantly improves early numeracy skills in young

children but also meets the developmental needs of children in the preoperational stage.

5 CONCLUSIONS

This study concludes that the use of the interactive multimedia *Ocean Numbers* is effective in improving early numeracy skills in young children. The results of the Paired Sample t-Test indicate a significant difference between pretest and posttest scores, which means that the intervention had a strong positive effect. The average score of the children increased from 43.95 in the pretest to 83.95 in the posttest. In addition, the N-Gain value of 0.71 falls into the high category, further strengthening the effectiveness of *Ocean Numbers* in developing children's numeracy skills.

The strength of *Ocean Numbers* lies in its integration of instructional animations, animated videos, and educational games, which together provide engaging, enjoyable, and meaningful learning experiences. This aligns with cognitive development theory, particularly Piaget's pre-operational stage, which emphasizes the importance of concrete and symbolic media in helping children understand abstract concepts.

Thus, this study reinforces the evidence that interactive multimedia can serve as an innovative and practical tool for early childhood teachers in facilitating enjoyable and meaningful numeracy learning.

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