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Development of E-LKPD Assisted by FlippingBook Based on Environmath to Improve Metaphorical Thinking Skills

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ABSTRACT

This research aims to develop an E-LKPD integrated with FlippingBook technology based on the Environmath approach, as well as to investigate the enhancement of students' metaphorical thinking skills before and after the implementation of the developed instructional materials. The study utilized a Research and Development (R&D) methodology guided by the ADDIE model, which comprises five sequential phases: analysis, design, development, implementation, and evaluation. Data were gathered through observations, expert validations of both material and media aspects, and assessments of students' metaphorical thinking abilities. The participants involved in this study included two material experts, three media experts, and twenty seventh-grade students from MTs Miftahul Falah Panumbangan. The findings revealed that during the analysis stage, a needs analysis, student analysis, and material analysis were conducted. In the design stage, test instruments were prepared, media and format were selected, and the initial product design was developed. The development stage includes the product development process, while at the implementation stage, E-LKPD was tested on students. Furthermore, at the evaluation stage, it was found that there was a significant increase in metaphorical thinking skills after students used E-LKPD assisted by FlippingBook based on environmath with the quality of the increase being in the high category.

Keywords: E-LKPD; environmath; flippingbook; metaphorical thinking skills

INTRODUCTION

Metaphorical thinking ability constitutes an essential aspect of mathematical problem-solving, as it enables students to articulate mathematical concepts through analogies grounded in relevant experiences, thereby rendering the concepts more concrete and comprehensible (Aziz et al., 2025; Dewi & Sørensen, 2023; Díaz-Chang & Arredondo, 2022; Nisaa et al., 2024). Through the use of metaphors, students can relate abstract ideas in mathematics to everyday situations or experiences, thus helping them to understand and apply mathematical ideas more effectively (Pramudiani & Sari, 2023; Rahmi et al., 2023).

The ability to think metaphorically provides opportunities for students to view mathematics not only as a collection of formulas and numbers, but as a means to explain and solve problems encountered in life (Tama et al., 2019). The ability to think metaphorically enables students to connect mathematical concepts that they already know with concepts that are being studied or that have not yet been understood (Ergusni, 2023; Mumcu et al., 2019; Septian et al., 2022; Setyaningsih & Firmansyah, 2022). In addition, this ability also helps in formulating alternative methods and finding solutions to the problems faced (Annizar & Zahro, 2020).

Several studies have shown that junior high school students' mathematical metaphorical thinking skills are still in the low category. At Al-Madina Junior High School, only 59% of students were able to demonstrate metaphorical thinking skills (Ramdhani & Sugiarni, 2018). Similar results were also observed among students in Banda Aceh, particularly those with a field-dependent cognitive style, indicating that they had not yet been able to meet the indicators of metaphorical thinking such as connect, relate, explore, analyze, transform, and experience in solving algebraic problems (Muthmainnah et al., 2021). These difficulties hinder the connection between mathematical concepts and previously acquired knowledge. In addition, students at SMPN 3 Ciamis with high levels of mathematical anxiety also show a tendency to make mistakes in metaphorical thinking, especially at the transform to experience stages (Hendarto, 2021).

The researcher conducted a preliminary study using a descriptive test on number material, which encompassed six indicators of metaphorical thinking ability. The test was administered to seventh-grade students of MTs Miftahul Falah. The results indicated that the average percentage of students who failed to meet the indicators of metaphorical thinking ability reached 56.33%, which falls into the high category. This condition is closely related to the learning process, which remains predominantly lecture-based and relies on conventional LKPD without the integration of innovative teaching materials developed by teachers. The limited availability of engaging instructional materials is one of the contributing factors to students' low levels of metaphorical thinking ability (Nurhasanah et al., 2019; Prastyo & Hartono, 2020).

The LKPD used so far tends to focus on delivering basic facts and procedures, not on developing metaphorical thinking skills, so that students are less trained to associate new concepts with ideas they already know. Research shows that without E-LKPD, students are less active, less involved in learning and have difficulty learning independently and developing problem-solving strategies (Ambarwati & Purnomo, 2023; Febriani & Medika, 2023; Hidayat & Aripin, 2023; Septian & Gustiana, 2022). In addition, the less than optimal use of technology causes low student interest in mathematics because learning becomes monotonous (Hermawan et al., 2022; Simamora & Winardi, 2024). Conventional learning approaches are also considered less capable of linking mathematical concepts to real-life contexts, and makes it challenging for students to comprehend abstract concepts (Apriani & Sudiansyah, 2024).

Based on previous research studies, theories and preliminary studies that have been conducted, learning innovations are needed that can help students apply mathematical theory in the context of life and encourage an increase in students' thinking abilities, especially metaphorical thinking abilities (Barwell, 2018). Therefore, the use of E-LKPD assisted by FlippingBook based on environmath is considered capable of being an alternative solution in more interesting and interactive mathematics learning (Apriliyani & Mulyatna, 2021; Özdemir, 2021). FlippingBook enables the presentation of instructional materials in an interactive eBook format featuring realistic page-turning effects, thereby fostering greater learner engagement and promoting a more dynamic and immersive learning environment (Marizal et al., 2022). FlippingBook serves as an electronic learning medium that integrates animation, text, video, images, and audio to create interactive simulations, thereby

increasing student engagement and making the learning experience more interesting (Imswatama & Saepuloh, 2025; Mahmud et al., 2023).

The novelty of this research lies in the development of an Environmath-based E-LKPD assisted by FlippingBook, designed to enhance students' metaphorical thinking skills in mathematics learning. The integration of the contextual Environmath approach with the interactive digital medium FlippingBook provides an engaging, reflective, and meaningful learning experience. Furthermore, this study develops an assessment instrument for mathematical metaphorical thinking skills based on six key indicators (connecting, relating, exploring, analyzing, transforming, and experiencing). Thus, this research offers novelty in its focus, innovation in media and learning approaches, and contribution to the development of a relevant instrument for measuring and improving metaphorical thinking skills.

Environmath learning is an environment-based mathematics learning with learning steps consisting of orientation, exploration, explanation, elaboration and evaluation. Environmath learning aims to integrate mathematical concepts with environmental issues and open the door to a deeper understanding of both fields (Pearl, 2020). In environmental mathematics learning, we not only create students who are competent in mathematics, but also a generation that cares about environmental challenges (Nopitasari & Juandi, 2020). The advantage lies in enabling students to learn mathematics through real-world contexts, thereby reinforcing their understanding of mathematical concepts as applied in everyday life situations. Therefore, the Environmath-based E-LKPD assisted by FlippingBook is expected to enhance students' metaphorical thinking skills.

RESEARCH METHODS

This study utilized a Research and Development (R&D) approach grounded in the ADDIE model, encompassing five structured phases: analysis, design, development, implementation, and evaluation. The participants of this study were 20 seventh-grade students from MTs Miftahul Falah Panumbangan in the 2024/2025 academic year. The data collection techniques encompassed (1) observation to analyze learning activities, media use in the classroom, and students' prior abilities; (2) validation by material and media experts to assess the validity of the Environmath-based FlippingBook-assisted E-LKPD in enhancing metaphorical thinking skills from both content and media perspectives; and (3) metaphorical thinking skill tests, consisting of pre-test and post-test on statistics material, to determine students' improvement after using the E-LKPD. Data analysis was conducted using SPSS Version 20, including descriptive analysis of the Environmath-based FlippingBook-assisted E-LKPD development procedure and hypothesis testing consisting of prerequisite analyses (normality and homogeneity tests) and the Wilcoxon test. Additionally, the N-Gain test was employed to assess the extent and quality of students' improvement in metaphorical thinking skills.

RESULTS AND DISCUSSION

The outcomes of the research and development of the FlippingBook-assisted E-LKPD grounded in the Environmath approach, aimed at improving students' metaphorical thinking skills in statistics, are presented as follows:

Analysis

The analysis stage represents the initial phase conducted by the researcher (Sugianti, 2020). The analysis stages conducted in this study include needs analysis, student analysis, and material analysis (Ashari, 2022). The results of the needs analysis show that the teaching materials that have been used in class are still conventional with an emphasis on mastery of basic facts and procedures, but have not encouraged the development of students' metaphorical thinking skills. In addition, students currently lack alternative mathematics instructional materials beyond the traditional LKPD to support independent learning. Students also show low interest in LKPD which only contains printed text on opaque paper, so it does not support learning motivation and active involvement in the learning process. The results of the student analysis show that the initial ability level of students in Class VII MTs Miftahul Falah in the realm of metaphorical thinking skills is still low. The results of the material analysis are formulating Learning Outcomes (CP), Learning Objectives (TP) in statistics material based on the Merdeka Curriculum used at MTs Miftahul Falah Panumbangan. Therefore, it is concluded that an E-LKPD assisted by FlippingBook based on environmath is needed in order to improve students' metaphorical thinking skills.

Design

At the design stage, tests and research instruments were prepared. The pretest and posttest questions consisted of one complex essay question. At this stage, media were also selected to develop E-LKPD. Researchers used the Canva application to create LKPD to then be converted into a flipbook with the help of FlippingBook. The design creation can be seen in Figure 1.

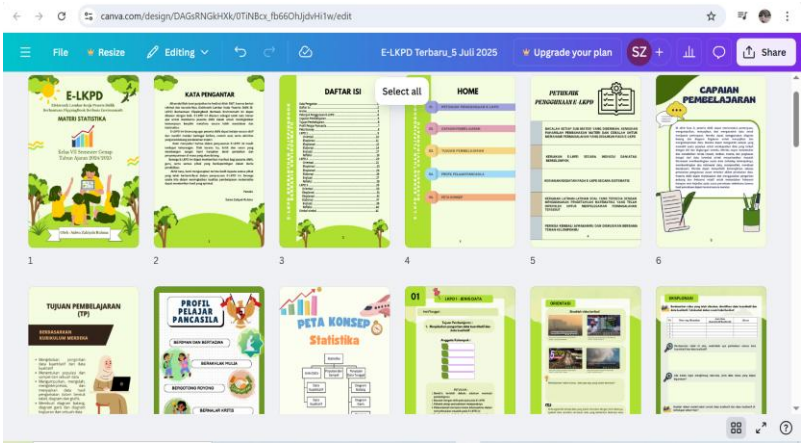

Figure 1. Making E-LKPD Design

The development of E-LKPD using the FlippingBook application is presented in the following image.

Figure 2. Development of E-LKPD

The selection of the FlippingBook-assisted E-LKPD format based on the Environmath approach was designed to present the material in an engaging manner, with the aim of enhancing students' enthusiasm and motivation to learn throughout the learning process. The results of the initial E-LKPD design are presented as follows:

Figure 3. Initial Design of E-LKPD

Development

The development stage was conducted prior to the implementation of the product in the classroom setting. At this stage, the validation and assessment processes were carried out by a panel of expert validators, consisting of two material experts and three media experts. The outcomes of the material validation analysis of the FlippingBook-assisted E-LKPD based on the Environmath approach are displayed in Table 1 below.

Table 1. Material Validation Results

Statement	Validators		Score Each Statement
	1	2	
1	4	4	8
2	4	4	8
3	4	4	8
4	4	4	8
5	4	3	7
6	4	3	7
7	4	3	7
8	4	4	8
9	4	4	8
10	4	3	7
Score obtained	40	36	76
Maximum score	40	40	80

The results of the validation of material experts on E-LKPD assisted by FlippingBook based on environmath to improve students' metaphorical thinking skills can be calculated as follows.

$$Validation\ percentage\ (S_v) = \frac{Score\ obtained}{Maximum\ score}\ x\ 100\%$$
$$= \frac{76}{80}\ x\ 100\%$$
$$= 95\ \%$$

The validation value percentage of 95% shows that the E-LKPD assisted by FlippingBook based on environmath to improve students' metaphorical thinking skills is valid.

The results of the media validation analysis on E-LKPD assisted by FlippingBook based on environmath are presented in Table 2 below.

Table 2. Media Validation Results

Statement	Validators			Score Each Statement
	1	2	3	
1	4	4	3	11
2	4	4	4	12
3	4	4	4	12
4	4	4	3	11
5	4	4	4	12
6	4	4	4	12
7	4	4	4	12
8	4	4	4	12
Score obtained	32	32	30	94
Maximum score	32	32	32	96

The results of media expert validation of E-LKPD assisted by Flippingbook based on environmath to improve students' metaphorical thinking skills can be calculated as follows.

$$Validation\ percentage\ (S_v) = \frac{Score\ obtained}{Maximum\ score}\ x\ 100\%$$
$$= \frac{94}{96}\ x\ 100\%$$

$$= 97.92\ \%$$

The validation value percentage of 97.92% shows that the E-LKPD assisted by FlippingBook based on environmath to improve students' metaphorical thinking skills is valid.

Implementation

At the implementation stage, a trial of E-LKPD assisted by FlippingBook based on environmath was conducted on statistics material in class VII MTs Miftahul Falah Panumbangan. At this implementation stage, students were given pretest questions, then given learning consisting of three meetings, namely discussing E-LKPD 1 on data types, E-LKPD 2 on population and samples and E-LKPD 3 on how to present data. In the next meeting, students were given posttest questions. The following is the implementation of learning in class VII presented in Figure 4.

Figure 4. Implementation of E-LKPD

Evaluation

The evaluation phase represents the final stage of the development research process. To assess the improvement in students' metaphorical thinking skills after utilizing the E-LKPD, a hypothesis test was conducted based on their pretest and posttest results. The normality of the data was tested using SPSS version 20, and the outcomes of the analysis are displayed in Table 3.

Table 3. Data Normality Test Using SPSS Version 20

Tests of Normality

	Shapiro Wilk		
	Statistics	df	Sig.
Pretest_KBM	.823	20	.002
Posttest_KBM	.759	20	.000

The results of the normality test revealed that the significance value (Sig.) for the pretest data was $0.002 < 0.05$, indicating that the data were not normally distributed. Likewise, the posttest data yielded a significance value of $0.000 < 0.05$, which also demonstrates non-normal distribution. Hence, according to the Shapiro–Wilk test, both the pretest and posttest data did not satisfy the assumption of normality. As a result, the data were subsequently analyzed using the Wilcoxon test. The outcomes of the Wilcoxon test are presented in Table 4.

Table 4. Wilcoxon Test Results

Test Statistics	
	Posttest - Pretest
Z	-3.826b
Asymp. Sig. (2-tailed)	.000

Based on Table 4, information was obtained that the value*asymp.sig. (2 tailed)*(0.000) < 0.05, so it is rejected, which means$H_o$there is a significant difference in the ability to think metaphoricallylearnersbetween before and after using E-LKPD assisted by FlippingBook based on environmath.

Next, an N-Gain analysis was conducted to see the quality of the increase in students' metaphorical thinking skills after using E-LKPD assisted by FlippingBook based on environmath with the following formula:

$$N\ Gain = \frac{Skor\ posttest - skor\ pretest}{Skor\ maksimal - skor\ pretest}$$

Based on the results, data obtained showed that 13 people or 65% of students experienced an increase in learning outcomes in the realm of metaphorical thinking skills which were in the high category, 5 people or 25% of other students experienced an increase in the medium category and 2 people or 10% of students were in the low category. The overall average N-Gain value is 0.75 which is included in the high category based on the N-Gain score interpretation criteria. This shows that learning using E-LKPD assisted by Flippingbook based on environmath is effective in improving metaphorical thinking skills with the quality of improvement including the high category.

The improvement in the quality of learning in this high category is driven by the activeness of students during the learning process. Research Ekasari et al. (2025) shows that the use of FlippingBook increases student engagement and learning outcomes, and is effective in developing thinking skills through the integration of text-based materials, images, graphics, and videos (Sofia & Loviana, 2024). FlippingBook technology acts as a cognitive mediator that facilitates the formation of mathematical metaphors. The ability of technology to present videos, images and materials allows students to be more motivated in learning mathematics (Taqwani et al, 2025). Research Liesandra & Nurafni (2022) shows that digital technology-based learning media has a major contribution in increasing students' motivation and learning outcomes. In addition, the appearance of E-LKPD assisted by FlippingBook which resembles a physical book with a page-turning effect provides a more interesting experience for students (Apriliyani & Mulyatna, 2021).

Environmath learning is also a learning that can significantly improve the mathematical metaphorical thinking skills of junior high school students. Environmath learning integrates environmental contexts into mathematical concepts, so that students can more easily understand and associate mathematical abstractions with real experiences around them (Halawa & Darmawan Harefa, 2024; Lisnani et al., 2023). This process facilitates the birth of metaphorical thinking that links mathematical ideas with concrete representations in the surrounding environment (Princess & Pratiwi, 2022). The integration of environmath in E-LKPD provides a real context that allows students to build connections between abstract mathematical concepts and phenomena they experience every day. This is in accordance with the principle of meaningful learning, namely that new knowledge is linked to existing

cognitive structures (Fitriyana, 2024). The environmath approach in E-LKPD allows students to relate mathematical concepts to environmental phenomena that they experience every day. This contextualization is very important in the formation of meaningful mathematical metaphors. Research Syarif (2024) shows that teaching materials that integrate environmental concepts with mathematics can improve students' thinking skills with an effective effect size.

Thus, the use of E-LKPD assisted by FlippingBook based on environmath is considered effective and able to improve students' metaphorical thinking skills through the integration of digital technology and environment-based learning.

CONCLUSION

Based on the results of the research on the development of E-LKPD assisted by FlippingBook based on the Environmath approach conducted on class VII students of MTs Miftahul Falah Panumbangan in the 2024/2025 academic year on statistics material, it was concluded that the development procedure of the FlippingBook-assisted E-LKPD grounded in the Environmath approach was carried out in accordance with the stages of the ADDIE development model. The analysis stage revealed that the teaching materials used were still conventional and did not stimulate students' thinking skills. Moreover, independent learning media other than conventional LKPD were limited, students showed low interest in monotonous LKPD, and the level of achievement in metaphorical thinking skills remained relatively low. In the design stage, activities included the preparation of test instruments, the selection of appropriate media, the determination of the format, and the creation of the initial design of the FlippingBook-assisted E-LKPD based on Environmath were carried out to enhance students' metaphorical thinking skills in statistical material. During the development stage, the instrument and E-LKPD were reviewed by the supervising lecturer and validated by media and material experts, with the results classified as valid. The implementation stage involved product trials with seventh-grade students, the administration of test items to measure metaphorical thinking skills, and the distribution of questionnaires to determine student and teacher responses toward the E-LKPD. Finally, the evaluation stage encompassed the assessment and analysis of the data obtained during the implementation phase.

The results of the hypothesis testing revealed a statistically significant difference in students' metaphorical thinking abilities before and after the implementation of the FlippingBook-assisted E-LKPD developed based on the Environmath approach. Furthermore, the average N-Gain value indicates that the improvement in students' metaphorical thinking skills falls within the *very good* category.

The E-LKPD assisted by FlippingBook based on the Environmath approach developed in this study is expected to be adapted to other mathematical topics by future researchers as an effort to improve various mathematical abilities, such as mathematical communication skills, problem solving, connections, reasoning, and critical thinking.

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