



DEVELOPMENT OF LEARNING CYCLE MATHEMATICS TEACHING MATERIALS CONTAINING P5 TO IMPROVE STUDENTS' CRITICAL-CREATIVE SKILLS

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Abstract. Critical and creative thinking skills in mathematics are essential competencies. However, many students still have difficulty understanding mathematical concepts because the learning approach is still conventional. The purpose of this study is to develop contextual and enjoyable mathematics teaching materials to improve students' critical and creative thinking skills through numeracy activities. In addition, the integration of the P5-based learning cycle can encourage holistic and applicable learning to real-world problems. The research method used the Borg & Gall Research and Development (R&D) model, which was modified into 8 stages. The research subjects were 60 fifth-grade students at SDN Inpres Dodirungga and Inpres Talabiu. Data collection instruments included validation sheets, response questionnaires, and tests. Data analysis used a completeness test, a mean difference test, and an N-gain test. The results showed that the pretest-posttest normality test had a P-value of 0.200 and 1.91 ($P > 0.05$), and the homogeneity test had a P-value of 0.82 and 0.398 ($P > 0.05$), indicating that the data were normally distributed and homogeneous. Meanwhile, the N-Gain scores for the control class (72.88) and the experimental class (72.73). Based on the results of the N-Gain test and the difference in means, it can be concluded that there was an increase in the pretest-posttest results of students (control-experimental), meaning that the development and use of P5-based learning cycle teaching materials had an effect on improving students' critical and creative thinking skills in elementary school.

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INTRODUCTION

Critical and creative thinking skills are essential 21st-century competencies (High Order Thinking Skills) that are very important to develop at the elementary school level (Kronberg & Griffin, 2020; Manurung et al., 2020; Saefudin, 2012; Sholikhah & Chamidah, 2022). These skills enable students to analyze, evaluate, and generate ideas independently (Nurwalidainismawati & Fauzi, 2023; Ratnasari et al., 2024; Suryaningsih et al., 2023). In the context of basic education, these abilities form the foundation for character building and reflective and adaptive thinking in response to contemporary challenges (Peter, 2022; Runisah, 2021). However, initial observations at SDN Inpres Doridungga show that mathematics learning has not been optimal in developing critical and creative thinking skills. Part of the learning process still uses lecture methods, lacks practice questions, and has minimal exploration activities. This makes it difficult for students to solve contextual mathematical problems independently, understand mathematical concepts, and produce a variety of solutions.

Several studies have shown that students tend to be passive in mathematics learning because it is dominated by lecture methods and problem-solving exercises that do not encourage the exploration of thinking ideas (Nurwalidainismawati, 2022; Suryani et al., 2024). Based on the results of the Minimum Competency Assessment (AKM) for 2022-2024, only 65.86% of elementary school students demonstrated numeracy skills in the medium to high category (Kemendikbudristek, 2022). Teacher interviews also indicate that the integration of numeracy culture and P5 Values remains low and suboptimal (Maulina et al., 2022; Natsir & Manaf, 2023; Rohim, 2023). Numeracy culture, which should foster mathematical thinking habits, has not been fully internalized in learning activities or student behavior (Kemendikbud, 2022).

To overcome these problems, innovative solutions need to be developed to integrate active

learning, character building, and high-level skills simultaneously. One relevant approach is the development of mathematics teaching materials based on the Learning Cycle that integrates the values of the Pancasila Student Profile (P5). The Learning Cycle, which consists of the stages of experiencing, exploring, explaining, elaborating, and evaluating, has been proven to encourage meaningful understanding through direct experience, reflection, and application (Chintya et al., 2023; Fajarsari et al., 2023; Lindang & Wewe, 2024; Utami et al., 2021; Yonanta et al., 2024). This model is in line with the principles of meaningful and constructivist learning, which have been proven to improve critical and creative thinking skills (Chintya et al., 2023; Fajarsari et al., 2023). Meanwhile, the integration of P5 in teaching materials provides space for students to develop independence, creativity, and critical reasoning through contextual projects and reflective discussions (Maula & Widiyono, 2022). Thus, the combination of the Learning Cycle and P5 content in mathematics teaching materials can be an effective strategy to improve students' critical and creative thinking skills while strengthening numeracy culture.

Previous researchers have extensively studied learning cycle models and teaching material development, but few have explicitly integrated P5 and numeracy culture in elementary schools (Simbolon, 2023; Horbo, 2023; Nuraeni et al., 2024; Salma, 2022; Stavinelbia, 2021; Triwahyuningtyas et al., 2024; Widana & Widyastiti, 2023). One previous study stated that developing learning cycle-based teaching materials can improve student learning outcomes, with an N-Gain value of 0.64, categorizing learning improvement as moderately good (Horbo, 2023). However, the results were limited to worksheets (LKS). Other research has shown that the developed electronic LKS is effective in strengthening elementary school students' numeracy literacy skills (Triwahyuningtyas et al., 2024). However, the development was limited to the use of the learning cycle and did not touch on the MBKM domain.

Previous studies have shown limitations, which presents an opportunity to develop P5-integrated teaching materials. Therefore, this study is urgent as an innovative effort to improve the quality of mathematics learning that is not only oriented towards cognitive learning outcomes, but also shapes the character and 21st-century competencies of students. This is supported by the results of research on which states that it is necessary to develop a learning model that focuses on improving students' critical and creative thinking skills in mathematics learning. The purpose of this study is to develop P5-based Learning Cycle mathematics teaching materials to improve students' critical and creative thinking skills through a culture of numeracy in elementary schools. Therefore, the focus of this study is to develop P5-based learning cycle mathematics teaching materials to improve students' critical and creative thinking skills through a culture of numeracy in elementary schools with active and independent learning activities.

RESEARCH METHODS

This research is a research and development (R&D) study with a mixed-method approach that refers to the Borg & Gall development model, which has been modified into 8 stages of research, namely: (1) literature study and analysis needs, (2) preparation design products, (3) initial product development, (4) limited testing, (5) initial product revision, (6) brief field testing, (7) final revision, and (8) finalization and publication (Rohmaini et al., 2020; Waruwu, 2024).

This study will be conducted in fifth grade at SDN Inpres Doridungga, located in Donggo District, Bima Regency, West Nusa Tenggara, and at SDN Inpres Talabiu, located in Wohu District, Bima Regency, West Nusa Tenggara. This study uses purposive sampling, which is the selection of samples based on the following criteria: (1) schools that have implemented the Merdeka curriculum with the P5 program (Pancasila student profile strengthening project); (2) schools with the same accreditation; (3) schools with teachers who are ready to implement learning cycle-based teaching materials (teacher qualifications); (4) the teaching materials are the same; and (5) schools that have a level of numeracy that still needs to be improved (follow-up to previous research). In this study, a limited trial will be conducted at SDN Inpres Doridungga with 20 students, while a largescale trial will be conducted at SD Inpres Doridungga and SDN Inpres Talabiu with 60 students.



Data collection techniques in this study used several instruments, including: (1) expert validation sheets: used to assess the feasibility of the teaching materials developed, covering mathematical content, learning cycle syntax, P5 values, LKPD, LKK, numeracy games, and pretest and posttest questions; (2) critical and creative thinking skills tests: developed and tested in advance for validity, reliability, discriminating power, and level of difficulty; and (3) teacher and student response questionnaires: used to determine the practicality and appeal of teaching materials.

Data analysis techniques include: Expert Validation: Involving three experts consisting of subject matter experts, learning design experts, and mathematics education experts to assess the feasibility of the product; Practicality Test: Based on the results of teacher and student response questionnaires to the teaching materials developed using average scores and questionnaire achievement percentages; and Effectiveness Test: Involving several analyses, namely average completeness and classical completeness tests, average difference tests between pre-tests and post-tests, and n-gain score tests to see improvements in critical and creative thinking skills. Prior to the N-Gain test, the following tests were conducted: Normality test using Kolmogorov-Smirnov and Homogeneity test using Levene's Test at a significance level of 5%.

RESULTS AND DISCUSSION

The results of this study indicate that the development of P5-based *learning cycle* mathematics teaching materials in improving students' critical and creative thinking skills through a culture of numeracy has met the criteria of validity, practicality, and positive effect. The findings are divided into several main topics, namely the validation of instruments and teaching materials, practicality of use, and learning effectiveness based on statistical tests, as described below:

1. Validation of Instruments and Teaching Materials

Before conducting research, all instruments and teaching material product development were first validated by a team of experts consisting of three people, two of whom were experts in product development, and one was an expert in assessment instruments. The subjects in the product development instrument focused on product quality, consisting of content, language, appearance, and technology, while the subjects in the assessment instrument consisted of critical and creative thinking validation sheets, student assessment sheets, LKPD, and LKK. The following is the form of the module developed, as shown in Figure 1.



Figure 1. Overview of Teaching Material Design

Figure 1 above is a display of the open material that was developed. The product development validation results had an average score of 3.9, while the assessment instrument validation results had an average score of 4. The comparison of average scores per validator is presented in Figure 2.

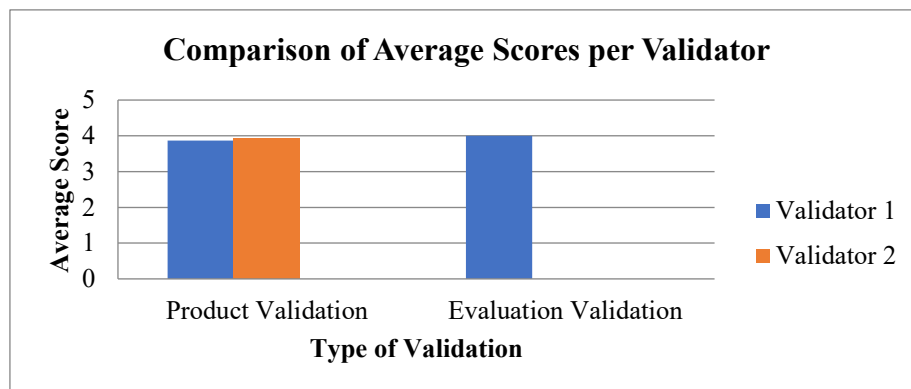


Figure 2. Validation Comparison Chart

Figure 2 is the average comparison score of the validation results by the validator team, both from product validation and from activity evaluation validation. In general, the results of the assessment of the product development validation sheet and the research instrument validation sheet are "suitable" for use. In line with the research conducted by [Nora et al. \(2022\)](#), the layout, text, color, images, and appearance of teaching materials will look neat and attractive if presented systematically, with supporting images that can improve the quality of learning. The teaching materials developed are designed in both online and offline formats, meaning that the teaching and learning activities in the materials are equipped with links that can be accessed online as an interactive learning tool. [Sari et al. \(2018\)](#) states that one of the advantages of teaching materials connected to links as a navigation tool is that it makes students more interactive and interested in interactive tests or questions, thereby enriching their learning experience.

2. Practicality Test

Initial product trials were conducted to determine the practicality criteria of the developed product. The trials were conducted on 25 students. This activity was planned to involve only 20 students, but based on consideration, the product trial involved all fifth-grade students. The results of the observation showed various responses given by students during the learning process. On the other hand, most students were able to analyze problems in the teaching materials by comparing two different ways of solving problems related to money, choosing the more efficient method related to the place value of numbers, and drawing logical conclusions from the data provided. This was also supported by P5 project-based activities through group discussions.

Furthermore, the results of student assessments of the product trial through the distribution of questionnaires showed that the teaching materials developed fell into the "very practical" category with an average score of 3.63 (scale of 1-4) and a percentage of 97.78%. Of the 25 students who participated in the trial, 2 students rated the developed teaching materials as "practical" on a scale, while the remaining 23 rated them as "very practical." After the initial trial was conducted, a large-scale trial (main trial) was carried out. The results of the teachers' assessment of the product development fell into the "practical" category with an average score of 3.95 (scale of 1-4) and a percentage of 79.16%. The positive assessment from teachers indicates that the developed "teaching materials" are easy to understand, interesting, and can be applied in classroom learning, especially for counting numbers. The comparison of the practicality of teaching materials based on teacher and student responses is illustrated in [Figure 3](#).

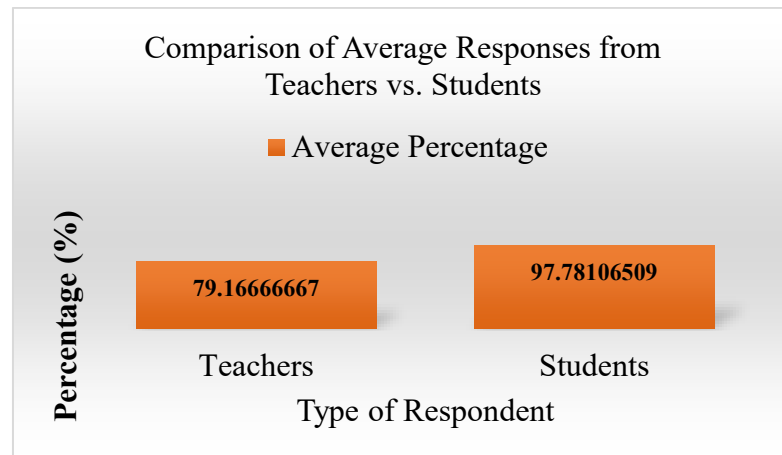


Figure 3. Teacher and Student Responses

Figure 3 shows the percentage of teacher and student responsiveness to learning activities designed in teaching materials. The above assessment results show that the practicality of the teaching materials developed is influenced by the learning cycle design, where the two stages in the model (engage and explore) can encourage students to be actively involved from the start of learning. This is in line with the view Egan et al. (2023) who emphasized that learning is a continuous process formed and reshaped through students' direct experiences. Furthermore, Gordon (2022) explained that the experiential learning cycle has four main stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. These four stages are interconnected and encourage students to explore real-life experiences, reflect, build conceptual understanding, and apply them in real-life actions. In line with this, the results of a meta-analysis conducted by Alnajjar & Ibrahim (2024) showed that the application of the learning cycle model has a significant impact on student learning success because it can foster active, constructivist-based learning. Thus, the use of a learning cycle design in developing teaching materials can increase practicality, attract learning interest, and help students understand concepts more deeply from the beginning of the learning process, especially in the material on whole numbers.

3. Learning Effectiveness Test

After testing the validity and practicality of the product, the researcher then conducted a learning effectiveness test. The results of the normality test of the pretest data in the control and experimental classes using Kolmogorov-Smirnov and the homogeneity test using Levene's test are shown in Table 1.

Tabel 1. Pretest-Posttest Data Analysis

Variable	Grub	Mean/SD	N	F (ANOVA)	P- value	η^2	Interpretasi
Pretest	Combined (control & experiment)	58,05/2,78	58	1,624	0,208	0,028	Not significantly different, equivalent
Posttest	Combined (control & experiment)	88,81/1,18	58	3,623	0,062	0,061	Not significant (smallmedium), there is a tendency for differences

Table 1 above is the result of a comparison of the normality and homogeneity tests of the pre-test and post-test scores of students carried out in the control class and in the experimental class. The results of the normality test analysis of the pretest data using the KolmogorovSmirnov test show that the sample size (N) of 58 samples with a P value or (Asymp. Sig. (2- tailed) of 0.200 means that $P > 0.05$, so the pretest data is said to be normally distributed. Meanwhile, the results of the homogeneity analysis of the pretest data using Levene's test showed that the sig (P-Value) = 0.82, indicating that $P > 0.05$. The test results in the ANOVA table also show that the Sig value = 0.208, indicating that $P > 0.05$. Thus, it can be concluded that the data variance is the

same or that the data is homogeneous. This means that both the control group and the experimental group have equivalent abilities on average.

The results of the normality test analysis of the post-test data using the KolmogorovSmirnov test show that the sample size (N) of 58 samples with a P value or (Asymp. Sig. (2- tailed) of 1.91 means that $P > 0.05$, so the post-test data is said to be normally distributed. Meanwhile, the results of the homogeneity analysis of the pretest data using Levene's test show that the sig (P-Value) = 0.398, which indicates that $P > 0.05$. The test results in the ANOVA table also show that the Sig value = 0.062, which indicates that the P value > 0.05 . Thus, it can be concluded that the data variants are the same or can be said to be homogeneous. This means that both the control group and the experimental group identified a tendency for differences in learning outcomes between the control group and the experimental group.

The following presents the scores obtained by students based on the results of the pretest and posttest for both the control class and the experimental class. The data presented shows an increase in student scores in both the control class and the experimental class. The data is presented in the following Figure 4.

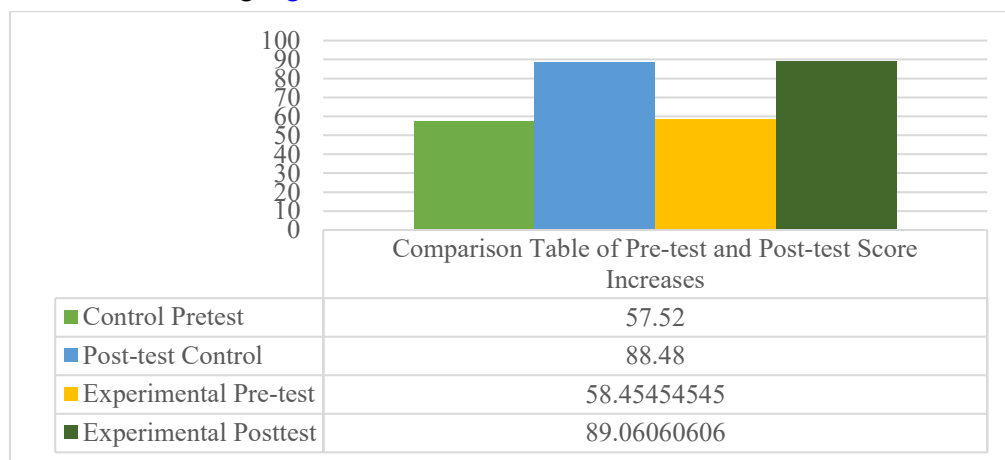


Figure 4. Comparison of Students' Pre-test and Post-test Scores

Figure 4 shows a learning effectiveness test conducted on 58 students, with 25 students in the control class and 33 students in the experimental class. The 58 data sets were tested for normality and homogeneity of variance. The average pretest score for the control class was 57.52, and the average posttest score for the control class was 88.48. Meanwhile, the average pretest score for the experimental class was 58.45 and the average posttest score for the experimental class was 89.06. Both the control class and the experimental class had a classical mastery score of 1. The N-Gain test results showed that the increase in learning outcomes between the control class and the experimental class was in the "high" category, with the interpretation that the teaching materials used were quite effective in improving students' critical and creative thinking skills in elementary school.

Next, test the difference in means using a paired sample test. Based on the results of the paired sample test, it is known that the sig. value (2-tailed) for the control class is $0.00 < 0.05$, so H_0 is rejected and the calculation of the T(table)value based on the df value with significance $\alpha/2$ s (0.025) is 2.064, while the T(calculated)value is 72.65. Thus, because the Tcalculated value is greater than the T-table value, H_0 is rejected. It can be concluded that there is a difference in the average pretest and posttest results of students in the control class during the learning process, meaning that the use of P5-based learning cycle teaching materials has an effect on improving students' critical and creative thinking skills in elementary school.

Similar to the control class, the results of the paired sample test in the experimental class showed that the sig. (2-tailed) value was $0.00 < 0.005$ and the Tcalculated calculation showed a value of 100.530 with Ttable 2.037. Both analyses indicate that H_0 is rejected, meaning that there is a difference in the mean pretest and posttest scores in the experimental class.

The results of the above study indicate an improvement in students' critical and creative

thinking skills using learning cycle-based teaching materials. The interpretation of the N-Gain test results provides an answer that the teaching materials are "quite effective" in developing students' critical and creative thinking skills. This is in line with the results of the research, which states that learning cycle-based teaching materials are considered to be able to stimulate students' thinking activities and improve learning outcomes, especially in abstract materials, because they can provide a more meaningful and contextual learning experience by building their own knowledge. Learning activities designed using the learning cycle model syntax supported by P5 activities through numeracy culture showed that students were enthusiastic during the learning process. The results of interviews with students and teachers indicate that the learning process was very enjoyable (Astuti et al., 2024; Damayanthi et al., 2022) states that the readiness of teachers in managing students and providing enjoyable learning facilities will result in optimal learning conditions in accordance with the learning objectives. Therefore, teachers' ability to implement the learning cycle model motivates students to learn better and becomes the main capital in developing a participatory learning atmosphere (Astuti et al., 2020; Damayanthi et al., 2022). In addition, numeracy activities are supported through project-based group activities (Berlian Wandiri, 2019; Faridah et al., 2022) states that project-based learning activities can improve students' numeracy skills. This can be seen in the learning outcomes of students from both the control class and the experimental class, which experienced an increase in both pretest and posttest scores. Priatna et al. (2017) adds that projects can increase student enthusiasm and activity in learning.

CONCLUSIONS AND SUGGESTIONS

Based on the results of the analysis and discussion, it can be concluded that the teaching materials developed are valid and suitable for use. The results of the normality test on the pretest data show a value of (Asymp. Sig. (2-tailed) = 0.200, which means $P > 0.05$, while the normality test on the posttest data shows that (Asymp. Sig. (2-tailed) is 1.91, which means $P > 0.05$, so both the pretest and posttest data are normally distributed. Furthermore, the results of the homogeneity analysis show that the sig (P-Value) = 0.82, with the ANOVA test showing Sig = 0.208, which means that the P value is > 0.05 . Meanwhile, the homogeneity analysis results show that the sig (P-Value) = 0.398, with the ANOVA test also showing Sig = 0.062, which indicates that the P value is > 0.05 . Thus, the data variance is homogeneous. This means that both the control group and the experimental group have equivalent abilities on average.

The results of the N-Gain test show that the teaching materials are "quite effective" in developing students' critical and creative thinking skills, with an average score of 72.88 for the control class and 72.73 for the experimental class. This means that there was an increase in learning outcomes before and after using the teaching materials. Furthermore, based on the results of the mean difference test, there was a difference in the mean between the pretest and posttest results of students in the control class and the experimental class during the learning process, meaning that the use of P5-based learning cycle teaching materials had an effect on improving students' critical and creative thinking skills in elementary school. The next research recommendation is to develop technology-based teaching materials that cover an entire semester of learning, so that the teaching materials can be used continuously without focusing on a single learning material.

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