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# IMPROVING STUDENTS' LEARNING OUTCOMES IN NON-NUMERICAL PATTERN RECOGNITION THROUGH PROBLEM-BASED LEARNING ASSISTED BY A PICTORIAL PATTERN BOARD IN ELEMENTARY SCHOOL

# PENINGKATAN HASIL BELAJAR POLA BUKAN BILANGAN MELALUI PROBLEM BASED LEARNING BERBANTUAN MEDIA PAPAN TEMPEL POLA BERGAMBAR DI SEKOLAH DASAR

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*learning outcomes; non-numerical patterns; Problem-Based Learning; Pictorial Pattern Board.*

**Abstrak**

*Penelitian ini bertujuan untuk meningkatkan hasil belajar murid kelas I pada materi pola bukan bilangan melalui penerapan Problem Based Learning berbantuan Media Papan Tempel Pola Bergambar di SDN 7 Talaga Jaya. Penelitian ini merupakan Penelitian Tindakan Kelas (PTK) model Kemmis dan McTaggart yang dilaksanakan dalam dua siklus, masing-masing meliputi perencanaan, pelaksanaan, observasi, dan refleksi. Subjek penelitian berjumlah 20 murid kelas I. Teknik pengumpulan data menggunakan observasi, tes, dan dokumentasi, sedangkan data dianalisis secara deskriptif kuantitatif dan kualitatif. Indikator keberhasilan ditetapkan apabila minimal 80% murid mencapai ketuntasan belajar. Hasil penelitian menunjukkan bahwa ketuntasan hasil belajar meningkat dari kondisi awal yang masih rendah menjadi 70% (14 murid) pada Siklus I dan meningkat lagi menjadi 90% (18 murid) pada Siklus II. Dengan demikian, penerapan Problem Based Learning berbantuan Media Papan Tempel Pola Bergambar terbukti dapat meningkatkan hasil belajar murid pada materi pola bukan bilangan di kelas I SDN 7 Talaga Jaya.*

**Abstract**

*This study aimed to improve the learning outcomes of first-grade elementary school students in learning non-numerical patterns through the implementation of Problem-Based Learning (PBL) assisted by a Pictorial Pattern Board at SDN 7 Talaga Jaya. This study employed Classroom Action Research (CAR) based on the Kemmis and McTaggart model, which was conducted in two cycles, each consisting of planning, implementation, observation, and reflection. The participants were 20 first-grade students. Data were collected through classroom observations, learning achievement tests, and documentation, and were analyzed using descriptive quantitative and qualitative approaches. The success criterion was established as at least 80% of students achieving the minimum learning mastery. The findings revealed a substantial improvement in students' learning outcomes. Learning mastery increased from a low baseline to 70% (14 students) in Cycle I and further improved to 90% (18 students) in Cycle II. These findings indicate that the implementation of Problem-Based Learning assisted by a Pictorial Pattern Board effectively improved students' learning outcomes in non-numerical pattern learning among first-grade students at SDN 7 Talaga Jaya.*

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## INTRODUCTION

Mathematics education plays a crucial role in developing students' logical reasoning, critical thinking, and problem-solving skills, which are essential competencies for lifelong learning. In elementary education, mathematics instruction should be aligned with children's cognitive development by providing concrete and meaningful learning experiences that facilitate conceptual understanding. One of the fundamental topics introduced in the first grade is non-numerical patterns, which emphasize recognizing, extending, and generalizing visual sequences. Developing pattern recognition skills at an early age is considered an important prerequisite for later learning of number concepts, algebraic reasoning, and mathematical generalization.

Non-numerical patterns consist of sequences of objects, shapes, or images arranged according to identifiable and predictable rules (Peni & Ningsih, 2024). According to Febryanti & Ahmad, (2024), students develop an understanding of patterns by identifying regularities through repeated observations of visual arrangements. Likewise, Chrisnawati et al., (2023) argue that recognizing patterns enables students to discover relationships, identify regularities, and construct mathematical generalizations based on concrete experiences before progressing to abstract reasoning. Consequently, strengthening students' understanding of non-numerical patterns is essential for establishing a solid foundation for subsequent mathematical learning.

Students' conceptual understanding is reflected in their learning outcomes, which remain one of the primary indicators of instructional effectiveness. Learning outcomes are strongly influenced by instructional strategies, classroom interactions, and the availability of appropriate learning resources (Amara et al., 2023). Furthermore, Santani et al., (2026) reported that mathematics learning outcomes improve when instruction actively engages students in meaningful learning activities that promote exploration, reasoning, and problem solving. Therefore, selecting instructional approaches that encourage active participation while accommodating young learners' developmental characteristics is essential for improving mathematics achievement.

Despite the importance of pattern learning, classroom observations conducted prior to this study indicated that many first-grade students experienced difficulties in identifying regularities and predicting subsequent elements in non-numerical patterns. Only 58.3% of students achieved the expected level of learning mastery, while the remaining students demonstrated inadequate conceptual understanding of visual patterns. Classroom observations further revealed that mathematics instruction was predominantly teacher-centered, with limited opportunities for students to explore concepts independently or engage in collaborative problem-solving activities. Moreover, the use of concrete instructional media was minimal, making it difficult for students to connect abstract mathematical ideas with tangible learning experiences. Since first-grade students are still developing through concrete learning experiences, instructional approaches supported by visual and manipulative media are particularly important for facilitating conceptual understanding.

One instructional approach that addresses these challenges is Problem-Based Learning (PBL). PBL encourages students to construct knowledge actively by investigating authentic problems, collaborating with peers, and developing solutions through inquiry-based learning (Mulyasari, 2022). Numerous studies have demonstrated that PBL improves students' conceptual understanding, critical thinking, and mathematical problem-solving abilities. However, the effectiveness of PBL can be further enhanced when supported by instructional media that provide concrete representations of mathematical concepts. Rahman et al., (2024) emphasize that instructional media facilitate communication between teachers and students, making learning materials more accessible and meaningful. Similarly, Salim et al., (2024) found that integrating

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appropriate instructional media with PBL significantly enhances students' engagement and problem-solving performance.

To support students' understanding of non-numerical patterns, this study employed a Pictorial Pattern Board, a visual and manipulative instructional medium specifically designed to help students observe, arrange, replicate, and extend pictorial patterns. The medium enables students to interact directly with pattern elements through hands-on activities, thereby supporting concrete learning experiences consistent with the cognitive characteristics of early elementary school students. Integrating the Pictorial Pattern Board into the PBL framework is expected to promote active learning while facilitating students' conceptual understanding of pattern regularities.

Previous studies have reported positive effects of both concrete instructional media and Problem-Based Learning on mathematics achievement. Nabila et al., (2025) found that the Polaste board effectively improved students' understanding of number patterns. Khofsoh, (2024) demonstrated that Problem-Based Learning significantly enhanced mathematics learning outcomes among first-grade elementary school students. Likewise, Khotimah, (2023)reported that board-based instructional media improved mathematics achievement by increasing students' mastery levels across successive instructional cycles. Although these studies provide evidence of the effectiveness of either instructional media or PBL, most have examined these approaches separately or within different mathematical topics. Limited research has specifically investigated the integration of Problem-Based Learning with a Pictorial Pattern Board to improve first-grade students' learning outcomes in non-numerical pattern learning.

Addressing this research gap, the present study aimed to examine the effectiveness of integrating Problem-Based Learning with a Pictorial Pattern Board in improving first-grade students' learning outcomes in non-numerical pattern learning. The findings are expected to contribute to the development of student-centered mathematics instruction by providing empirical evidence regarding the effectiveness of combining inquiry-oriented learning with concrete instructional media to enhance conceptual understanding among young learners.

## METHOD

This study employed a quantitative approach using a Classroom Action Research (CAR) design based on the model developed by (Arikunto et al., 2020). The CAR model consisted of four iterative stages: planning, acting, observing, and reflecting. Classroom Action Research was selected because it enables teachers to systematically improve instructional practices through cyclic interventions until the predetermined success indicators are achieved.

The study was conducted at SDN 7 Talaga Jaya, Talaga Jaya District, Gorontalo Regency, Indonesia, during the second semester of the 2025/2026 academic year (February-March 2026). The participants comprised all 20 first-grade students, including 10 boys and 10 girls. The study was implemented in two action cycles. Cycle I consisted of two instructional sessions conducted on 9 and 10 February 2026, whereas Cycle II consisted of one instructional session conducted on 2 March 2026.

The study aimed to improve students' learning outcomes on non-numerical patterns through the implementation of the Problem-Based Learning (PBL) model supported by a picture-pattern board instructional medium. The research variables comprised three components. The input variable referred to the students' initial conditions, including prior knowledge, learning readiness, and the availability of learning resources. The process variable was the implementation of the Problem-Based Learning model assisted by the picture-pattern board following the standard PBL instructional syntax. The output variable was the improvement in students' learning outcomes on non-numerical pattern concepts, as measured by achievement test scores and the level of classical learning mastery.

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During the planning stage, the researcher prepared the teaching module (Deep Learning Lesson Plan), student worksheets, the picture-pattern board instructional media, teacher and student observation sheets, and learning achievement test instruments. The action stage involved implementing the five phases of the Problem-Based Learning model, namely: (1) orienting students to the problem, (2) organizing students for learning, (3) guiding the investigation process, (4) developing and presenting solutions, and (5) analyzing and evaluating the problem-solving process, as described. The classroom teacher implemented the instructional intervention, while the researcher and an independent observer monitored teacher performance and student learning activities using structured observation sheets. During the reflection stage, the observation findings and learning outcomes were analyzed to identify necessary improvements for the subsequent cycle whenever the predetermined success criteria had not yet been achieved.

The primary instructional medium used in this study was the picture-pattern board, a manipulative visual learning aid consisting of a display board and detachable picture cards that enabled students to identify, imitate, and extend non-numerical patterns. The supporting instructional materials included the teaching module (Deep Learning Lesson Plan), student worksheets, teacher and student observation sheets, learning achievement tests, and documentation of classroom activities.

Data were collected through classroom observations, achievement tests, and documentation. Classroom observations were conducted to collect data on teacher performance and student learning activities during the implementation of the instructional intervention. Achievement tests were administered at the end of each action cycle to assess students' learning outcomes, whereas documentation, including classroom photographs, instructional materials, and other supporting records, served as supplementary evidence for the implementation of the study.

The research instruments consisted of teacher observation sheets, student observation sheets, and learning achievement tests. The achievement tests were developed based on the intended learning outcomes for non-numerical patterns, including students' ability to identify, imitate, and extend non-numerical patterns. The Cycle I test consisted of four items, including one multiple-choice question and three short-answer questions, whereas the Cycle II test consisted of six items, including one multiple-choice question and five short-answer questions. Prior to data collection, all research instruments were reviewed through expert judgment by the academic supervisor and the classroom teacher to ensure their content validity and alignment with the instructional objectives and learning indicators.

Observation data were analyzed using descriptive quantitative analysis based on percentage calculations according to the following formula:

$$NP = \frac{R}{SM} \times 100\%$$

Description:
Where:
NP = percentage score obtained;
R = score obtained by the student;
SM = maximum possible score.

The observation results were subsequently classified according to the criteria presented in Table 1.

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Table 1. Classification Criteria for Teacher and Student Activity Observation

| Percentage (%) | Score | Category |
|---|---|---|
| 85–100 | 4 | Excellent |
| 70–84 | 3 | Good |
| 55–69 | 2 | Fair |
| 40–54 | 1 | Poor |
| <40 | 0 | Very Poor |

Source: Adapted from Kusumah and Dwitagama, as cited in Arzaq et al., (2022).

Students' learning outcomes were analyzed by calculating each student's final achievement score using the following formula.

$$Final\ Score = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100$$

Student responses were scored using a predetermined scoring rubric. In Cycle I, each item received 2 points for a correct answer and 1 point for an incorrect answer, resulting in a maximum possible score of 8. In Cycle II, the same scoring procedure was applied, with a maximum possible score of 12. Each student's final score was calculated by dividing the total score obtained by the maximum possible score and multiplying the result by 100. The students' learning outcomes were then classified according to the school's Minimum Learning Achievement Criteria (KKTP), as presented in Table 2.

Table 2. Classification Criteria for Students' Learning Outcomes

| Percentage (%) | Category | Follow-up Action |
|---|---|---|
| 0–40 | Inadequate Achievement | Comprehensive remedial instruction |
| 41–65 | Below Mastery Level | Targeted remedial instruction |
| 66–85 | Achieved Mastery | No remedial instruction required |
| 86–100 | Achieved Mastery | Enrichment activities |

Source: Minimum Learning Achievement Criteria (KKTP), SDN 7 Talaga Jaya.

The percentage of classical learning mastery was calculated using the following formula:

$$Final\ Score = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100$$

where:
PK = percentage of classical learning mastery;
n = number of students obtaining a score of 66 or above; and
N = total number of students.

The criteria for classical learning mastery are presented in Table 3.

Table 3. Criteria for Classical Learning Mastery

| Percentage (%) | Category |
|---|---|
| 80–100 | Excellent |
| 60–79 | Good |
| 40–59 | Fair |
| 20–39 | Poor |
| <20 | Very Poor |

Source: Adapted from Akid, as cited in Fitria et al., (2024).

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The study was considered successful when all predetermined success indicators were achieved: (1) teacher activity reached a minimum of 80%, classified as Good; (2) student activity reached a minimum of 80%, classified as Good; and (3) at least 80% of the students obtained a score of 66 or higher, in accordance with the school's Minimum Learning Achievement Criteria (KKTP), indicating improved learning outcomes in non-numerical pattern concepts.

## RESULT AND DISCUSSION

### Result

#### a. Preliminary Observation

The preliminary observation was conducted on Monday, July 22, 2025, through an interview with the Grade 1 classroom teacher at SDN 7 Talaga Jaya. The interview findings indicated that mathematics instruction on non-numerical patterns still faced several challenges, including low student engagement during learning activities, limited participation in answering and asking questions, and suboptimal use of instructional media and learning models aligned with the characteristics of the topic. These conditions affected students' learning outcomes, with some students failing to meet the predetermined mastery criterion.

Based on the initial classroom data involving 24 students, 14 students (58.3%) achieved the mastery criterion, while 10 students (41.7%) did not. These data were used to describe the initial learning conditions and to identify problems related to the teaching and learning of non-numerical patterns. Following the problem identification process, the classroom action research was conducted with 20 students, comprising 10 male and 10 female students, who served as the subjects of the intervention.

The difference in the number of students between the initial condition and the intervention stage indicates that the preliminary observation data were used as diagnostic data to describe the learning conditions before the intervention, whereas the data from Cycle I and Cycle II were used to analyze changes in the learning outcomes of the research subjects throughout the intervention. Therefore, direct comparisons across cycles were conducted using data from the 20 students who participated as research subjects in the classroom action research.

A test instrument was used to assess students' ability to understand non-numerical patterns. The test blueprint was developed based on the Learning Objective Achievement Criteria (KKTP) and the learning indicators, which included the abilities to identify, reproduce, and continue non-numerical patterns. The test was administered at the end of each cycle. Cycle I consisted of four items, whereas Cycle II consisted of six items, comprising fill-in-the-blank and multiple-choice questions. Instrument validation was conducted to ensure that the test items were aligned with the learning objectives, KKTP, learning indicators, and students' characteristics. When expert judgment was employed, the instrument was reviewed by lecturers and/or teachers with relevant expertise before being administered in the study.

The scoring procedure assigned a score of 2 for each correct answer, 1 for an incorrect answer, and 0 for an unanswered item. The maximum score was 8 in Cycle I and 12 in Cycle II. Students' final scores were calculated using the following formula:

$$Final\ Score = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100$$

Based on these initial conditions, an improvement intervention was implemented through the application of the Problem-Based Learning (PBL) model supported by a pictorial pattern board as instructional media.

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**b. Results of Cycle I Implementation**

Cycle I was conducted over two instructional sessions. The learning activities employed the Problem-Based Learning (PBL) model supported by a pictorial pattern board as instructional media. The learning activities focused on developing students' abilities to identify, reproduce, rearrange, and extend non-numerical patterns. In the first session, students observed examples of patterns involving pictures and colors, identified the underlying pattern rules, and completed incomplete patterns. In the second session, the activities were extended through exercises in reproducing and rearranging patterns using picture cards, color cards, and simple sound patterns.

Both instructional sessions followed the stages of the PBL model, including orienting students to the problem, organizing students into groups, facilitating inquiry, presenting the results, and conducting evaluation and reflection. The activities in the two sessions were structured progressively to provide students with learning experiences that moved from observing and recognizing patterns toward the ability to reconstruct patterns based on given examples. The results of the observation of teacher activities in Cycle I, Session 1 are presented in Table 4.

Table 4. Results of the Observation of Teacher Activities in Cycle I, Session 1

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 8 | 28.6% |
| Good | 7 | 25.0% |
| Fair | 9 | 32.1% |
| Poor | 4 | 14.3% |
| Total | 28 | 100% |

Source: Teacher Activity Observation Results

As shown in Table 4, of the 28 observed indicators, 8 indicators (28.6%) were rated as excellent, 7 indicators (25.0%) as good, 9 indicators (32.1%) as fair, and 4 indicators (14.3%) as poor. The teacher obtained a score of 75 out of a maximum score of 112, corresponding to an activity percentage of 67.0%, which was categorized as fair. These findings indicate that the implementation of the learning activities during the first session still required improvement, particularly in providing clear activity instructions, facilitating group work, and managing student engagement throughout the problem-solving process. The results of the observation of student activities in Cycle I, Session 1 are presented in Table 5

Table 5. Results of the Observation of Student Activities in Cycle I, Session 1

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 4 | 26.7% |
| Good | 4 | 26.7% |
| Fair | 4 | 26.7% |
| Poor | 3 | 20.0% |
| Total | 15 | 100% |

Source: Student Activity Observation Data

As shown in Table 5, of the 15 observed indicators, 4 indicators (26.7%) were rated as excellent, 4 indicators (26.7%) as good, 4 indicators (26.7%) as fair, and 3 indicators (20.0%) as poor. The students' activity score was 39 out of a maximum of 60, corresponding to 65.0%, which was categorized as fair. These findings indicate that some students had begun to engage in activities involving pattern observation and construction; however, others remained less focused, lacked confidence in participating in discussions, and were not yet actively involved in presenting their answers.

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The observation findings served as the basis for reflection and informed improvements to the learning activities in the second session. The improvements focused on providing clearer instructions, strengthening group facilitation, using the pictorial pattern board more purposefully, and providing students with greater opportunities to communicate their observations and explain the reasoning behind the sequence of patterns they identified. The results of the observation of teacher activities in Cycle I, Session 2 are presented in Table 6.

Table 6. Results of the Observation of Teacher Activities in Cycle I, Session 2

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 8 | 28.6% |
| Good | 16 | 57.1% |
| Fair | 4 | 14.3% |
| Poor | 0 | 0.0% |
| Total | 28 | 100% |

Source: Teacher Activity Observation Data

As shown in Table 6, teacher activity in Cycle I, Session 2 improved compared with the first session. Of the 28 observed indicators, 8 indicators (28.6%) were rated as excellent, 16 indicators (57.1%) as good, and 4 indicators (14.3%) as fair. No indicators were rated as poor. The teacher activity score reached 88 out of a maximum of 112, corresponding to 78.6%, which was categorized as good.

This improvement indicates that refinements in the use of instructional media, provision of instructions, and facilitation during group activities were associated with improved implementation of the learning process. Nevertheless, the achievement of 78.6% remained below the predetermined success criterion of ≥80%; therefore, the intervention was continued in Cycle II. The results of the observation of student activities in Cycle I, Session 2 are presented in Table 7.

Table 7. Results of the Observation of Student Activities in Cycle I, Session 2

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 6 | 40.0% |
| Good | 6 | 40.0% |
| Fair | 2 | 13.3% |
| Poor | 1 | 6.7% |
| Total | 15 | 100% |

Source: Student Activity Observation Data

As shown in Table 7, of the 15 observed indicators, 6 indicators (40.0%) were rated as excellent, 6 indicators (40.0%) as good, 2 indicators (13.3%) as fair, and 1 indicator (6.7%) as poor. The student activity score reached 47 out of a maximum of 60, corresponding to 78.3%, which was categorized as good. Compared with the first session, in which the activity score was 65.0%, this represented an increase of 13.3 percentage points. Students became more actively engaged in observing, discussing, constructing patterns, and presenting their group work. However, this achievement had not yet met the predetermined success criterion of ≥80%. A summary of teacher activity throughout Cycle I is presented in Table 8.

Table 8. Summary of Teacher Activity in Cycle I

| No. | Session | Percentage (%) | Category |
|---|---|---|---|
| 1 | Session 1 | 67.0% | Fair |
| 2 | Session 2 | 78.6% | Good |
| | Cycle I Average | 72.8% | Good |

Source: Teacher Activity Observation Data

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As shown in Table 8, teacher activity increased from 67.0% in the first session to 78.6% in the second session. The average teacher activity score in Cycle I was 72.8%, which was categorized as good. Although there was an increase of 11.6 percentage points between the two sessions, the achievement remained below the predetermined success criterion of ≥80%. The reflection findings were subsequently used as the basis for refining the intervention in Cycle II. A summary of student activity throughout Cycle I is presented in Table 9.

Table 9. Summary of Student Activity in Cycle I

| No. | Session | Percentage (%) | Category |
|---|---|---|---|
| 1 | Session 1 | 65.0% | Fair |
| 2 | Session 2 | 78.3% | Good |
| | Cycle I Average | 71.6% | Good |

Source: Student Activity Observation Data

As shown in Table 9, student activity increased from 65.0% in the first session to 78.3% in the second session. The average student activity score in Cycle I was 71.6%, which was categorized as good. The increase of 13.3 percentage points indicates an improvement in student engagement following the implementation of instructional improvements. However, the achievement had not yet met the minimum success criterion of 80%; therefore, the intervention was continued in Cycle II. Students' learning outcomes in Cycle I were assessed using an evaluation test consisting of four items, with a maximum possible score of 8. The learning mastery results are presented in Table 10.

Table 10. Student Learning Outcome Scores in Cycle I

| No. | Learning Outcome | Number of Students | Percentage |
|---|---|---|---|
| 1 | Achieved mastery | 14 | 70% |
| 2 | Did not achieve mastery | 6 | 30% |
| | Total | 20 | 100% |

Source: Student Learning Outcome Achievement Data, Cycle I

As shown in Table 10, of the 20 students who participated in the evaluation, 14 students (70%) achieved the mastery criterion, while 6 students (30%) did not. The mastery rate of 70% remained below the predetermined success criterion of ≥80%. These findings provided the basis for reflection and subsequent refinement of the intervention in Cycle II.

**c. Results of Cycle II Implementation**

Cycle II was conducted as a follow-up to the reflection findings from Cycle I. The intervention was refined by providing more systematic explanations, supplying a pictorial pattern board for each group, improving the instructions in the student worksheets, strengthening facilitation during group discussions, and providing students with greater opportunities to express their ideas and present their group work.

The learning activities in Cycle II focused on developing students' ability to extend non-numerical patterns using pictures, colors, and simple sounds. Students were guided to observe relationships among pattern elements, determine the sequence of the patterns, discuss possible answers, and explain the reasoning behind their selection of pattern elements. Thus, the learning activities emphasized not only the final answers but also students' understanding of the underlying pattern rules. The results of the observation of teacher activities in Cycle II are presented in Table 11.

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Table 11. Results of the Observation of Teacher Activities in Cycle II

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 18 | 64.3% |
| Good | 10 | 35.7% |
| Fair | 0 | 0.0% |
| Poor | 0 | 0.0% |
| Total | 28 | 100% |

Source: Teacher Activity Observation Data

As shown in Table 11, of the 28 observed indicators, 18 indicators (64.3%) were rated as excellent and 10 indicators (35.7%) as good. No indicators were rated as fair or poor. The teacher activity score reached 102 out of a maximum of 112, corresponding to 91.1%, which was categorized as excellent. This achievement exceeded the predetermined success criterion of ≥80%.

This improvement indicates that the refinements made based on the reflection findings from Cycle I contributed to improved implementation of the learning activities. The teacher demonstrated greater effectiveness in organizing groups, presenting learning problems, facilitating the inquiry process, providing feedback, and guiding students through the reflection process. The results of the observation of student activities in Cycle II are presented in Table 12

Table 12. Results of the Observation of Student Activities in Cycle II

| Activity Rating | Number of Indicators | Percentage |
|---|---|---|
| Excellent | 10 | 66.7% |
| Good | 5 | 33.3% |
| Fair | 0 | 0.0% |
| Poor | 0 | 0.0% |
| Total | 15 | 100% |

Source: Student Activity Observation Data

As shown in Table 12, of the 15 observed indicators, 10 indicators (66.7%) were rated as excellent and 5 indicators (33.3%) as good. No indicators were rated as fair or poor. The student activity score reached 55 out of a maximum of 60, corresponding to 91.7%, which was categorized as excellent and exceeded the predetermined success criterion of ≥80%.

This achievement indicates that students became more actively engaged in observing patterns, collaborating in groups, using the pictorial pattern board, completing the student worksheets, and communicating their ideas. These findings demonstrate improved student engagement following the refinement of group management and teacher facilitation. A summary of teacher activity in Cycle II is presented in Table 13.

Table 13. Summary of Teacher Activity in Cycle II

| No. | Session | Percentage (%) | Category |
|---|---|---|---|
| 1 | Session 1 | 91.1% | Excellent |
| | Cycle II Average | 91.1% | Excellent |

Source: Teacher Activity Observation Data

As shown in Table 13, teacher activity in Cycle II reached 91.1%, which was categorized as excellent. This achievement met the study's predetermined success criterion of ≥80%.. A summary of student activity in Cycle II is presented in Table 14.

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Table 14. Summary of Student Activity in Cycle II

| No. | Session | Percentage (%) | Category |
|---|---|---|---|
| 1 | Session 1 | 91.7% | Excellent |
| | Cycle II Average | 91.7% | Excellent |

Source: Student Activity Observation Data

As shown in Table 14, student activity in Cycle II reached 91.7%, which was categorized as excellent. This achievement indicates that the success criterion for student activity of ≥80% had been met. Students' learning outcomes at the end of Cycle II were assessed using an evaluation test consisting of six items, with a maximum possible score of 12. The learning mastery results are presented in Table 15.

Table 15. Student Learning Outcome Scores in Cycle II

| No. | Learning Outcome | Number of Students | Percentage |
|---|---|---|---|
| 1 | Achieved mastery | 18 | 90% |
| 2 | Did not achieve mastery | 2 | 10% |
| | Total | 20 | 100% |

Source: Student Learning Outcome Achievement Data, Cycle II

As shown in Table 15, of the 20 students who participated in the evaluation, 18 students (90%) achieved the mastery criterion, whereas 2 students (10%) did not. Compared with Cycle I, the learning mastery rate increased from 70% to 90%, representing an increase of 20 percentage points. The achievement of 90% exceeded the study's predetermined success criterion of ≥80%; therefore, the intervention was concluded after Cycle II.

Overall, the findings demonstrate positive changes in teacher activity, student activity, and learning mastery following the refinement of the intervention. Teacher activity increased from an average of 72.8% in Cycle I to 91.1% in Cycle II. Student activity increased from 71.6% to 91.7%, while the learning mastery rate among the research subjects increased from 70% in Cycle I to 90% in Cycle II. Thus, all predetermined success criteria were achieved in Cycle II.

It should be noted that the preliminary observation involved 24 students, whereas the Cycle I and Cycle II data involved 20 students who served as the subjects of the classroom action research. Therefore, direct comparisons across cycles can only be made using data from the 20 students who participated in both Cycle I and Cycle II. The preliminary observation data served to describe the initial classroom conditions and provide a basis for problem identification. The development of learning mastery from the initial condition through Cycle I and Cycle II is presented in Figure 1.

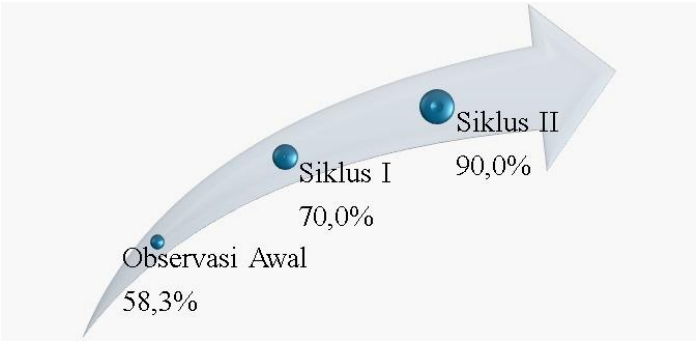


Figure 1. Comparison of Learning Mastery Rates between the Initial Condition and the Intervention Cycles

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Note: The initial-condition data involved 24 students, whereas the Cycle I and Cycle II data involved 20 students who served as the subjects of the classroom action research.

**Discussion**

This classroom action research aimed to improve the learning outcomes of Grade 1 students on non-numerical patterns through the implementation of the Problem-Based Learning (PBL) model supported by a pictorial pattern board at SDN 7 Talaga Jaya. The initial classroom condition, involving 24 students, showed that 14 students (58.3%) achieved the mastery criterion, whereas 10 students (41.7%) did not. These data provided the basis for problem identification and the implementation of the intervention. Subsequently, the classroom action research was conducted with 20 students as the research subjects. The evaluation results showed that the learning mastery rate among the research subjects reached 70% in Cycle I and increased to 90% in Cycle II. Teacher activity also increased from an average of 72.8% in Cycle I to 91.1% in Cycle II, while student activity increased from 71.6% to 91.7%.

The changes observed in Cycle I indicate that the implementation of PBL supported by the pictorial pattern board began to provide students with opportunities to engage in learning activities. However, the observation results showed that some students remained less focused, lacked confidence during discussions, and experienced difficulties in determining how patterns should be continued. From the teacher's perspective, several aspects of instruction also remained suboptimal, particularly in providing activity instructions, facilitating group work, and guiding students when they encountered difficulties. These conditions were reflected in the teacher activity rate of 72.8%, student activity rate of 71.6%, and learning mastery rate of 70% in Cycle I, all of which remained below the predetermined success criterion of ≥80%.

Based on the reflection conducted after Cycle I, several improvements were implemented in Cycle II. These included providing more systematic explanations, supplying a pictorial pattern board for each group, clarifying the instructions in the student worksheets, strengthening facilitation during discussions, and providing students with greater opportunities to communicate their ideas. These improvements were accompanied by increases in teacher activity to 91.1% and student activity to 91.7%. The learning mastery rate also increased to 90%. Within the context of classroom action research, these changes indicate improvements in learning outcomes following the refinement of the intervention based on reflection on the preceding cycle. However, these findings should not be interpreted as evidence of a statistically tested causal relationship because the study did not employ inferential statistical analysis or a comparison group.

The pictorial pattern board provided students with a more concrete learning experience. Non-numerical patterns, which may otherwise be abstract for young learners, were represented through pictures, colors, and arrangements of objects that could be directly observed and manipulated. Students could observe the sequence of pattern elements, compare the positions of different elements, and then attempt to determine the subsequent element by moving or arranging cards on the board. These activities helped students connect visual observations with the underlying pattern rules. Thus, the pictorial pattern board functioned not merely as a visual aid but also as a medium through which students could gain direct experience in identifying and constructing patterns.

Group work further supported the learning process. When solving pattern-related problems, students had opportunities to compare their observations, formulate hypotheses about pattern sequences, and discuss the reasoning underlying their selected answers. Students who had already understood the pattern could assist peers who were experiencing difficulties, while the teacher could monitor the discussion process and provide support according to students' needs. The increase in student activity from 65.0% in the first session to 78.3% in the second session of Cycle I and

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subsequently to 91.7% in Cycle II indicates that student engagement developed following improvements in group management and teacher facilitation.

The stages of Problem-Based Learning provided structure for these activities. During the problem orientation stage, students were guided to understand the pattern-related problem that needed to be solved. During the organization stage, students worked in groups and distributed tasks related to problem solving. During the investigation stage, students observed pattern elements, identified relationships among them, and attempted to determine the continuation of the pattern with the support of the pictorial pattern board. During the presentation stage, students were given opportunities to explain their work and the reasoning behind their selected patterns. The evaluation and reflection stage then enabled students to review both the process and the answers they had developed. This sequence positioned students as active participants in observing, experimenting, discussing, and communicating their understanding.

The findings are consistent with Jean Piaget's theory of cognitive development, which suggests that elementary school-aged children are predominantly within the concrete operational stage and that conceptual understanding can be facilitated when learning is supported by objects or representations that can be directly observed and manipulated. Through the use of the pictorial pattern board, students gained concrete learning experiences that may have facilitated their understanding of non-numerical patterns. In addition, the constructivist perspectives associated with Vygotsky and Piaget, as discussed by Puspitasari, (2022), emphasize that knowledge construction is supported when learners actively participate in learning activities and obtain direct learning experiences. This perspective was reflected in the activities of observing, discussing, and constructing patterns using the pictorial pattern board.

The findings are also consistent with those of Nabila et al., (2025), who reported that the use of the Polaste board media could support students' understanding of numerical patterns. The similarity lies in the use of concrete media to facilitate students' observation and understanding of pattern relationships. However, Nabila et al., (2025) focused on numerical patterns, whereas the present study focused on non-numerical patterns using a pictorial pattern board.

Khofsoh, (2024) focused primarily on the implementation of the Problem-Based Learning model without using concrete media as a supporting component of the learning process. This finding is relevant to the present study because PBL provides a structure through which students can understand problems, collaborate, conduct investigations, and communicate their findings. The distinction is that the present study integrated PBL with a pictorial pattern board, enabling the investigation process in learning non-numerical patterns to be supported by visual and manipulable objects.

Furthermore, Khotimah, (2023) reported that the use of board-based instructional media contributed positively to improvements in mathematics learning outcomes. The similarity with the present study lies in the use of a board-based medium that enables students to interact directly with the learning material. The difference concerns both the learning content and the instructional model. The present study combined a pictorial pattern board with PBL to teach non-numerical patterns to Grade 1 students.

Taken together, previous studies support the view that concrete media and active learning approaches can provide students with opportunities to gain direct experiences in mathematics learning. In the present study, the pictorial pattern board was integrated with PBL so that the pattern problems presented by the teacher could be translated into concrete activities involving observation, arrangement, experimentation, discussion, and explanation of patterns. This combination also provided opportunities for the teacher to offer direct support when students encountered difficulties.

The novelty of this study lies in the integration of the Problem-Based Learning model with a pictorial pattern board for teaching non-numerical patterns. The concrete medium supported the

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investigation process in PBL because students could manipulate pictures, colors, and simple sound patterns to identify the appropriate sequence. At the same time, group work and teacher facilitation enabled students to formulate hypotheses, test pattern arrangements, and explain the reasoning behind their selected answers. Based on the study data, this integration was accompanied by increases in teacher activity, student activity, and learning mastery from Cycle I to Cycle II.

The increase in learning mastery from 70% in Cycle I to 90% in Cycle II indicates a change in the achievement of the research subjects following the refinement of the intervention. Nevertheless, because the study did not employ inferential statistical analysis or a comparison group, these findings cannot be used to conclude that the implementation of PBL supported by a pictorial pattern board statistically caused the improvement in learning outcomes or was more effective than other instructional models. Therefore, the findings are more appropriately interpreted as changes in learning processes and outcomes among the participating students following the progressive refinement of the intervention.

This study has several limitations that should be considered. First, the classroom action research involved only 20 students from a single class at one school; therefore, the findings cannot readily be generalized to students with different school characteristics or learning environments. Second, the study was conducted over two cycles, meaning that the data describe changes during the intervention period and do not establish whether the observed learning gains were sustained over the long term. Third, the Cycle I assessment consisted of four items with a maximum score of 8, whereas the Cycle II assessment consisted of six items with a maximum score of 12. Therefore, comparisons across cycles were based on final scores and mastery rates rather than raw scores. Fourth, the study did not include a control or comparison group and did not employ inferential statistical analysis; consequently, the findings were not intended to estimate the magnitude of an effect or establish statistical effectiveness.

These limitations do not diminish the practical value of the findings in the context of classroom improvement. The results suggest that refining instructional actions based on reflection, using concrete media, implementing group work, presenting pattern-related problems, and providing teacher facilitation may serve as alternative approaches for developing instruction on non-numerical patterns among Grade 1 students. The increase in teacher activity from 72.8% to 91.1%, student activity from 71.6% to 91.7%, and learning mastery from 70% to 90% indicates that the predetermined success criteria were achieved in Cycle II.

Overall, the findings indicate positive changes in teacher activity, student activity, and learning mastery in non-numerical patterns among the research subjects following the implementation of the Problem-Based Learning model supported by a pictorial pattern board. These changes occurred alongside refinements to the intervention based on the reflection findings from Cycle I, the use of concrete and manipulable instructional media, collaborative group work, pattern-based problem solving, and more targeted teacher facilitation in Cycle II. Because all predetermined success criteria had been achieved, the classroom action research was concluded after Cycle II.

## CONCLUSSION AND RECOMENDATIONS

### Conclussion

This study aimed to improve Grade 1 students' learning outcomes on non-numerical patterns through the implementation of the Problem-Based Learning (PBL) model supported by a pictorial pattern board at SDN 7 Talaga Jaya. The findings indicate that, following the implementation of the intervention across two cycles, improvements were observed in both the learning process and learning outcomes. The learning mastery rate increased from 70% in Cycle I to 90% in Cycle II. In

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addition, the average teacher activity score increased from 72.8% to 91.1%, while the average student activity score increased from 71.6% to 91.7%. Based on these findings, the implementation of the Problem-Based Learning model supported by a pictorial pattern board in the investigated classroom was associated with improvements in instructional implementation, student engagement, and learning mastery in non-numerical patterns, ultimately achieving the predetermined success criteria established for this classroom action research.

**Recommendations**

Based on the findings of this study, teachers intending to implement the Problem-Based Learning (PBL) model supported by a pictorial pattern board are recommended to provide adequate instructional media so that each group can use the materials effectively throughout the learning process. Teachers should also provide clear and systematic instructions, actively facilitate students at each stage of the problem-solving process, and provide opportunities for students to explain the reasoning underlying their answers. These practices may help strengthen student engagement and participation during learning activities.

For future researchers, this study may be extended to different mathematics topics or grade levels by involving larger samples, incorporating comparison groups, and extending the duration of the intervention. Such extensions may provide more comprehensive evidence regarding the implementation of the Problem-Based Learning model supported by a pictorial pattern board across different instructional contexts and may further clarify its potential contribution to students' mathematics learning.

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