The Implementation of Pop-Up Book Media: Potential Implication on Mathematics and Science Learning Outcomes

Akina1*, Dian Nitami Rukmana Paeri1, Mufidah1, Nuraini1

1Mathematics Department, Universitas Tadulako, Palu, Indonesia.

Abstract: Mathematics is important to the broader implications for science education, as science and mathematics are inherently interconnected. The use of interactive and engaging media such as pop-up books can be a valuable tool for teaching natural science concepts and improving student learning outcomes. This study aims to improve students' mathematics learning outcomes through the implementation of pop-up media during the learning process. The current study also describes potential implication of the result to the natural science learning. This research is classroom action research (CAR). This research was conducted at SD Inpres Baru with 16 third grade students as subjects for two cycles. Research data were analyzed descriptively-quantitatively. Data on student learning outcomes were collected using multiple-choice tests. In addition, observation sheets are also used to collect data on teacher and student activities. The results of the research in cycle I showed that the average student score reached 68.87 with classical completeness reaching 43.75%, while the results of observations of teacher activity (68%) and students (69%) were in the sufficient category. In cycle II, the average student score increased to 87 with classical completeness reaching 87.5%. There were better teacher (89%, good category) and student (91%, very good category) activity compared to the results in cycle I. Based on the results of the study, it can be concluded that the implementation of Pop-up Book learning media in learning mathematics can improve students' learning outcomes on flat shape material. The result can be applied to natural science teaching as well, where teachers need to be more active and effective in guiding students in experiments and demonstrations, and ensure that students are actively participating in the learning process.

Keywords: Learning outcomes; Mathematics learning; Pop-up Book; Science Learning

Introduction

Based on the theory of cognitive development, elementary school students are generally in the operational operational stage (Ranjitkar et al., 2019) which involves simple representational processes in the thinking process (Sukaisih et al., 2020). In response to these conditions, learning in elementary schools is emphasized to be more motivating, interactive, and inspiring to provide space so that creativity can grow according to students' talents and interests (Sudarsih, 2021). Unfortunately the development of information and technology is always accompanied by the emergence of learning problems such as learning that is less interesting (Biazus & Mahtari, 2022; Pertiwi et al., 2019) which results in a decrease in student learning outcomes (Alika & Radia, 2021; Hardiansyah & Mulyadi, 2022) especially in mathematics (Amir, 2015; Nisa et al., 2018).

Mathematics is a scientific discipline that plays an important role in human life (Nasruddin et al., 2020). Mathematics according to some opinions is the mother of science because it is closely related to other disciplines, especially physics (Retnawati et al., 2018), chemistry (Korpershoek et al., 2015) and various other exact science groups. Mathematics involves logic and quantitative calculations Hamdani et al. (2020), so that it has implications for the importance of mastering mathematics for students so they can solve problems in life related to mathematical calculations (Everdi, 2022). Mathematics is the science of logical reasoning and problems related to numbers. The development of

How to Cite:
learning mathematics in children according to Piaget's learning theory goes through 4 stages, namely concrete, semi-concrete, semi-abstract, abstract (Fahma & Purwaningrum, 2021). Therefore, mathematics must be studied by students starting from the elementary school level up to tertiary institutions.

Many people, especially Elementary School students, think that learning mathematics is an unpleasant activity, students sit for hours devoting their thoughts to a subject both presented by the teacher and what is being faced at the study table (Sudarsih, 2021). These activities are always felt as a burden to deepen knowledge. As educators, teachers have a responsibility in solving learning problems to facilitate learning that is meaningful and not boring (Syafari & Montessori, 2021).

The results of pre-research conducted through observation and interviews with class III guardians at SD Inpres Baru, learning activities in mathematics still use the lecture method and the lack of use of learning media so that the average student score in mathematics is still lower than the standard value determined by the school. The scores obtained by students in mathematics are still low compared to other subjects. The average score for mathematics learning outcomes (score= 47.5) was found to be lower compared to other subjects in semester I such as science (score= 62.0), Indonesian (score= 62.0), citizenship (score= 59.5), and social science (score = 57.5). This proves that students' grades in mathematics were very low in the final semester I test because the teacher had not optimized the supports in the learning process such as interesting strategies in the process of teaching and learning activities.

In line with the results of pre-research, Fimansyah (2015) stated that there was an insignificant interaction effect between learning strategies and students' interest in learning mathematics which affected student learning outcomes, due to students' interest in learning being mediocre because it was influenced by several factors such as facilities that lacking, teacher attention, parental attention or materials for calculating the circumference and area of triangles are less interested.

Learning that can be used to create learning that attracts students' attention, one of which is by utilizing learning media in the learning process. Learning media is anything that can convey messages through various channels, can stimulate students' thoughts, feelings and willingness so that they can encourage the creation of a learning process to add new information to students so that learning objectives can be achieved properly (Alika & Radia, 2021). Appropriate learning media can provide positive benefits for students to increase learning enthusiasm, students develop according to their interests and speed, provide stimulation and equality of experience, provide perceptions of the same conception (Maghiroh et al., 2020). This is supported by research that has successfully applied instructional media to improve student learning outcomes (Afandi et al., 2021).

A pop-up book is a book that has moving parts or has three-dimensional elements and provides an interesting story visualization, and displays images that can move when the page is opened (Afandi et al., 2021). The display in the pop-up book is very attractive and makes it possible to enhance and illustrate student learning material in an interesting way (Colidiyah, 2018). From this opinion it can be seen that Pop-up Book media is a book-shaped media that has three-dimensional elements and. In Pop-up Books, material is conveyed in the form of attractive images because there are sections which, when opened, can move, change or give the impression of arising.

Pop-up book media is one of the learning media that is practical to use, easy to carry, looks in two and three dimensions which can increase student enthusiasm for learning and can use media independently or in groups. Through the use of this media, it is hoped that teachers can change the boring learning atmosphere for SD Inpres Baru students to become more interesting, so that students become motivated to learn, and pay close attention to the lessons delivered by the teacher. So that with an interesting learning atmosphere this will be able to improve students' low mathematics learning outcomes.

Based on this background, this study seeks to improve student learning outcomes through the application of pop-up book media in mathematics learning. This research is important to do to provide a new point of view in learning mathematics at SD Impres Baru on flat shape material. The results of previous research have also shown the potential of pop-up book media in increasing student learning outcomes in science subjects (Safri et al., 2017), effective in increasing learning success (Praheto & Sayekti, 2018). Furthermore, pop-up book media are claimed to be used to increase student learning autonomy (Elmunsyah et al., 2019).

The current research use of pop-up book media in mathematics teaching to improve student learning outcomes. Mathematics is an essential scientific discipline that requires logical reasoning and quantitative calculations (Rahmawati, 2022). Elementary school students are in the operational stage of cognitive development, which involves simple representational processes in thinking. However, students often find learning mathematics unpleasant and boring (Haeriah et al., 2022). Teachers have a responsibility to make learning meaningful and interesting. The use of learning media is an effective way to make learning more attractive to students (Kusumawati et al., 2022).

Learning media is anything that can convey messages through various channels and stimulate students' thoughts, feelings, and willingness to learn (Khairunnisah et al., 2021). The appropriate use of
learning media can increase learning enthusiasm, provide stimulation and equality of experience, and provide perceptions of the same conception (Mayarni et al., 2021; Suryati et al., 2021, 2022). Pop-up book media is a practical and easy-to-carry learning medium that has two and three-dimensional elements that can increase student enthusiasm for learning. Pop-up books are book-shaped media that convey material in the form of attractive images that can move, change or give the impression of arising.

**Method**

This research is a Classroom Action Research (CAR) whose main objective is to improve student learning outcomes in mathematics, especially in learning flat shapes. This research was carried out in 2 (two) cycles with each cycle consisting of 4 (four) stages of activities referring to the Kemmis and Mc Taggart model PTK design, namely: (1) planning stage, (2) action implementation stage, (3) implementation stage observation or observation, and (4) the reflection stage. This research was conducted on class III students at Impres Baru Elementary School with 16 students (6 boys; 10 girls) on geometric material as subjects.

The planning stage is carried out by making learning plans in the form of: (1) RPP (Learning Implementation Plan) using pop-up book media, (2) student learning outcomes assessment instruments, and (3) observation sheets of the implementation of learning and student learning activities. The implementation stage, namely carrying out actions in the form of learning activities in accordance with the devices that have been made at the planning stage in accordance with the RPP (Learning Implementation Plan). The observation stage includes observing the implementation of learning and student learning activities on the learning process carried out by the teacher, as well as evaluating student learning outcomes at the end of each learning cycle. Observation activities are carried out by asking colleagues to observe the implementation of learning and student learning activities during learning and putting a check mark (✓) on the observation sheet. Evaluation activities are carried out at the end of each learning cycle by providing ten items oriented to indicators of cognitive learning outcomes in flat shape material. The reflection stage, namely looking back at the implementation of the process and learning outcomes achieved in each cycle, then finding alternative solutions to improve processes and results in the next cycle. The flowchart of this research can be illustrated as shown in Figure 1.

Data collection is done through giving tests and observations. The test consists of an exploratory test and a final action test. An exploratory test is given with the aim of knowing students' ability to solve questions related to the material being taught. The final test of the action is given at the end of each action given with the aim of knowing the mastery of the concept and improving students' mathematics learning outcomes after giving the action. While observations are made during the learning activities take place. The implementation was carried out by filling in the format prepared by the researcher with the aim of knowing the activities and behavior of the research subjects during the learning process.

The research data were analyzed descriptively-quantitatively. Teacher and student activity data obtained through observation sheets were analyzed and expressed as a percentage using the Equation 1.

\[
\text{average score} = \frac{\text{obtained score}}{\text{maximum score}} \times 100\% \quad (1)
\]

The results of the analysis obtained are then categorized based on the categorization adapted from (Asiyah, 2022) as presented in Table 1.

<table>
<thead>
<tr>
<th>Score (%)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>91 &lt; score ≤ 100</td>
<td>Very good</td>
</tr>
<tr>
<td>71 &lt; score ≤ 90</td>
<td>Good</td>
</tr>
<tr>
<td>51 &lt; score ≤ 70</td>
<td>Enough</td>
</tr>
<tr>
<td>31 &lt; score &lt; 50</td>
<td>Not good</td>
</tr>
<tr>
<td>0 &lt; score ≤ 30</td>
<td>Very not good</td>
</tr>
</tbody>
</table>

Data on student learning outcomes were analyzed quantitatively based on the yad score obtained in each...
cycle. The frequency of students who were declared to have achieved individual and classical mastery criteria was also determined in this study. The completeness score of individual students is determined using the Equation 2.

\[
\text{score} = \frac{\text{obtained score}}{\text{maximum score}} \times 100 \tag{2}
\]

While the classical completeness of students as a group is expressed as a percentage which is determined using the Equation 3.

\[
\text{score} = \frac{\text{number of students completed}}{\text{number of students}} \times 100 \tag{3}
\]

Students are declared complete individually if the score obtained is ≥ 65 according to the Minimum Completeness Criteria that apply at SD Inpres Baru. On the other hand, students are declared classically complete if the percentage of classical completeness achieved is ≥ 70%.

Result and Discussion

Pre-action results

Pre-action activities are carried out through pre-tests with simple flat shape materials. The results of the pre-action showed that students had difficulties in solving the questions given. Evidenced by the low percentage of students' classical completeness (12.5%) and individual completeness (2 students). Pre-action results are presented in Table 2.

Table 2 shows the highest score (70) and lowest score (20) obtained by students in the pre-action stage. The percentage of students' classical completeness (12.5%) was declared not to meet the standard to be declared complete (70%). Students have difficulty working on initial test questions because students do not understand the concept of material properties of plane shapes and are also not familiar with simple flat shapes. So it is necessary to apply learning actions that can attract students' attention to study the properties of flat shapes so that they are easy to understand. The application of interesting learning is one of the supporters to improve student learning outcomes. The application of learning media is an option that has the potential to achieve this goal.

<table>
<thead>
<tr>
<th>Acquisition Aspect</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum score</td>
<td>70.00</td>
</tr>
<tr>
<td>Minimum score</td>
<td>20.00</td>
</tr>
<tr>
<td>Number of student</td>
<td>16.00</td>
</tr>
<tr>
<td>Number of Completed Students</td>
<td>2.00</td>
</tr>
<tr>
<td>Classical completeness percentage</td>
<td>12.50%</td>
</tr>
</tbody>
</table>

Cycle I Results

Cycle I consisted of 1 meeting with the time allocation for each meeting being 2 hours or 70 minutes and continued with the final test of cycle I on the same day. The researcher acts as a teacher, the class teacher acts as an observer for the activities of the teacher and students in cycle I. The observer is guided by the observation sheet that has been prepared. The final results of the cycle I action test are presented in Table 3.

<table>
<thead>
<tr>
<th>Acquisition Aspect</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum score</td>
<td>95.00</td>
</tr>
<tr>
<td>Minimum score</td>
<td>52.00</td>
</tr>
<tr>
<td>Number of student</td>
<td>16.00</td>
</tr>
<tr>
<td>Number of Completed Students</td>
<td>7.00</td>
</tr>
<tr>
<td>Classical completeness percentage</td>
<td>43.75%</td>
</tr>
</tbody>
</table>

Based on Table 3 it can be seen that the highest score analysis obtained by students is 95 while the lowest score is 52 out of 16 students who took the test. There were 7 students who were declared complete with a classical completeness percentage of 43.75%. The acquisition of student scores increased after implementing learning with the application of pop-up book learning media from the acquisition of pre-action test scores (12.5%) compared to the results of the first cycle of action (43.75%). The Acquisition of Classical Mastery has not yet reached the set indicator. Thus, this research is still considered unsuccessful because it has not reached the set indicators so it needs to be continued in the implementation of cycle II actions.

Observation of Teacher and Student Activities

Observation of teacher activities is carried out with the aim of seeing the suitability between the learning carried out in class and the learning implementation plan made previously. Observation of the teacher's activity was assessed by the observer; in this case it was carried out by a class III teacher at SD Inpres Baru. Based on the results of observations of teacher activity, the total score in cycle I was 49 out of a maximum score of 72 so that an average percentage of 68% was obtained in the sufficient category. The results obtained have not reached the indicators that have been set, and show that
teacher activities still need to be improved.

Observations of student activities are carried out during class learning by filling out the observation sheets provided. Observation of student activity aims to see the suitability and increase in student activity in participating in ongoing learning. Based on the results of observations of student activity, it showed that the total score in cycle I was 50 out of a maximum score of 72 so that an average percentage of 69% was obtained in the sufficient category. The results obtained have not reached the indicators that have been set, and this shows that student activities still need to be improved.

Cycle I Reflection

Reflection was carried out to analyze the data obtained from the actions in cycle I to find out the deficiencies in cycle I which were used as the basis for improvements in the actions in cycle II. Based on the test results and the results of learning observations observed by observers in cycle I, things were still lacking, such as (1) the teacher did not master the class in carrying out learning activities; (2) teachers do not make students active in participating in the learning process to the fullest so that there are still students who do not understand the material being taught; and (3) some students were busy playing the pop-up books that were distributed so they didn't pay attention to the teacher's explanation.

This is in line with Mufida opinion (2021) that efforts are needed to increase teacher readiness in teaching, namely: mastery of mathematics learning materials, preparation of characterized Mathematics lesson plans, and the ability to link the material being taught with more varied and interesting methods in learning mathematics needs to be intensified integrated character. Thus some of these things become a reference for improvement for researchers in cycle II.

Cycle II Results

The implementation of cycle II actions was carried out in accordance with the stages of direct learning using the Pop-up Book media and then giving the final cycle II test which was carried out on the same day as the implementation of cycle II actions to find out student learning outcomes through the use of Pop-up Book learning media with The number of essay questions is 10 items. The results of the cycle II test analysis are presented in Table 4.

Table 4. Cycle I Test Analysis Results

<table>
<thead>
<tr>
<th>Acquisition Aspect</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum score</td>
<td>100.00</td>
</tr>
<tr>
<td>Minimum score</td>
<td>55.00</td>
</tr>
<tr>
<td>Number of student</td>
<td>16.00</td>
</tr>
<tr>
<td>Number of Completed Students</td>
<td>14.00</td>
</tr>
<tr>
<td>Classical completeness percentage</td>
<td>87.50%</td>
</tr>
</tbody>
</table>

Based on Table 4 it can be seen that the highest score obtained by students is 100 while the lowest score is 55, out of 16 students who took the test. There were 14 students who were declared complete with a classical completeness of 87.5%. This shows that there is an increase in student learning outcomes from cycle I to cycle II. These results have reached the standard of action success (70%), so the research was not continued to the next cycle.

Observation of Teacher and Student Activities

Based on the results of observations of teacher activities, it is known that the total score in cycle II is 57 out of a maximum score of 64 with an average percentage of 89% (good criteria). On the other hand, the results of observations of student activity also showed an increase in cycle II. The total score in cycle II is 58 out of a maximum score of 64 with an average percentage of 91% (very good criteria). The results obtained have reached the indicators set, so that in this cycle the research was declared successful. These results are closely related to the use of pop-up book media in this research (Figure 2 & Figure 3). The use of media serves as the actualization of abstract concepts learned by students. Consistent with this statement, instructional media is recognized as an effective communication tool in learning Atubi (2023), thus having a positive impact on students' learning outcomes (Prastiti et al., 2023).

Figure 2. Right triangle in pop-up book media

Cycle II Reflection

Based on the results of learning tests, observations of teacher activities and student activities in cycle II it can be stated that learning in the classroom is optimal according to learning objectives. This is inseparable from the intensity of learning carried out through the application of pop-up book media which is a means of increasing student learning outcomes.
The results of this study are in line with the opinion of Mufidah et al. (2021) that the higher the learning intensity, the higher the learning outcomes.

**Potential implication and implementation on natural Science learning**

The current research highlights the importance of the use of learning media in natural science teaching, especially in mathematics. Learning media can provide positive benefits to students, including increased learning enthusiasm, student development according to their interests and speed, and equality of experience (Devi et al., 2021). Pop-up book media is a valuable learning medium that can help make learning more interesting and engaging for students. By utilizing this media in teaching mathematics, teachers can create a more attractive learning atmosphere that can improve students' low learning outcomes in mathematics.

The use of pop-up book media in mathematics teaching can be an effective way to improve student learning outcomes. Teachers can use this learning medium to change the boring learning atmosphere for students and make learning more meaningful and interesting (Riawan et al., 2020). By using appropriate learning media, teachers can stimulate students' thoughts, feelings, and willingness to learn, thus achieving the learning objectives properly (Kaukaba & Lutfi, 2022). Therefore, it is essential to incorporate the use of learning media, such as pop-up books, into natural science teaching to enhance student engagement and improve learning outcomes. The use of Pop-up Book media, which is an attractive and interesting learning tool, has been found to improve student learning outcomes. The use of relevant learning media can be beneficial in natural science teaching as well, especially in teaching topics that require visual or hands-on learning, such as experiments and demonstrations (Djedu et al., 2021).

The results showed that student scores increased significantly after implementing learning with the Pop-up Book learning media (Table 4). This suggests that the use of relevant learning media can significantly enhance student learning outcomes. This finding can be applied to natural science teaching as well, where students often learn through experiments and demonstrations. The use of relevant and appropriate learning media can help students understand complex concepts and improve their learning outcomes (Sani et al., 2022). The current study emphasizes the need for teachers to master the class in carrying out learning activities and make students active in participating in the learning process to the fullest. The finding can be applied to natural science teaching as well, where teachers need to be more active and effective in guiding students in experiments and demonstrations, and ensure that students are actively participating in the learning process (Muhali, 2019).

**Conclusion**

This research is said to be successful by looking at the resulting goals in accordance with the provisions of classroom action research. Based on the results of research and data analysis, it can be concluded that the application of Pop-up Book learning media can improve student learning outcomes in class III mathematics learning at SD Inpres Baru. This can be seen from the student learning outcomes obtained in the first cycle, which was 43.75%, increased in the second cycle to 87.5% and achieved the performance indicator target, which exceeded 70%. In addition, the results of the analysis of student and teacher activities in cycle I obtained an average percentage of student activity of 69% and was in the sufficient category while for teacher activity an average percentage was obtained of 68% in the same category, namely sufficient. In cycle II, the results of the analysis of student activity obtained an average percentage of student activity was 91% and was in the very good category. Furthermore, the results of the analysis of teacher activity in cycle II were 89% in the good category. The results of this study indicate that the management of learning in cycle II has increased from cycle I.

**Acknowledgements**

The research would like to thank the teachers and students of SD Inpres Baru who were involved during the research process.

**Author Contribution**

Conceptualization, methodology, formal analysis, writing—review and editing by Akina; investigation, writing—original draft preparation by Dian Nitami Rukmana Paeri; writing—review and editing by Mufidah, writing—original draft preparation by Nuraini.
Funding
No specific grant or funding was given to this educational research from any private institution, public or ganization or nonprofit corporation.

Conflict of Interest
The researchers declare no conflict of interests.

References


