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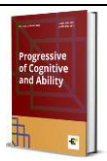

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Enhancing Mathematics Learning Outcomes on Fractions through the Use of Puzzle Media among Seventh-Grade Students at SMP IT Lentera

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ABSTRACT

Purpose – This study aims to investigate the effectiveness of puzzle media in improving mathematics learning outcomes on the topic of fractions among seventh-grade students at SMP IT Lentera. The research is motivated by the difficulties students often face in understanding fractions, which are considered abstract and challenging.

Methodology – The study employed a Classroom Action Research (CAR) approach, conducted in two cycles consisting of planning, implementation, observation, and reflection. The participants were 30 seventh-grade students. Data were collected through tests and observations, and analysed descriptively to examine learning outcomes and mastery levels.

Findings – The results showed a significant improvement in student achievement. The average score increased from 60 in the pre-cycle to 72 in Cycle I and 82 in Cycle II. Classical mastery also rose from 40% to 66.7% and finally to 86.7%. These findings indicate that puzzle media is effective in making abstract mathematical concepts more understandable and engaging.

Novelty – The originality of this study lies in the application of puzzle-based learning strategies to the teaching of fractions, which are usually perceived as difficult.

Significance – The study provides practical implications for teachers seeking innovative strategies to enhance student engagement and achievement in mathematics learning.

Keywords: Classroom action research; Fractions; Innovative learning strategies; Mathematics learning outcomes; Puzzle media; Student engagement.

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1. Introduction

Mathematics is one of the subjects that plays an important role in developing logical, analytical, critical, and systematic thinking skills. According to Hudoyo (2017), mathematics is a discipline whose structure consists of interrelated concepts that must be understood step by step. Therefore, mathematics learning should not merely emphasise procedures but also focus on conceptual understanding (Kilpatrick et al., 2001).

One of the essential yet difficult mathematics topics for junior high school students is fractions. Fractions serve as the foundation for understanding algebra, ratios, probability, and other advanced concepts. According to Kurniasih (2018), students' difficulties in learning fractions generally lie in understanding the part-whole relationship, errors in finding common denominators, and weak comprehension of fraction operations. This challenge arises because fractions are abstract, while seventh-grade students are still at Piaget's concrete operational stage. At this stage, students more easily understand concepts presented through tangible objects or visual representations (Ni & Zhou, 2005).

In practice, students' learning outcomes on fractions remain low. PBL can improve both problem-solving abilities and learning independence in mathematics education. The Problem-Based Learning (PBL) model has demonstrated significant effectiveness in enhancing students' mathematical skills and learning outcomes (Aropiq et al., 2025). In mathematics education, a crucial aspect lies in the teacher's role in facilitating opportunities for students to engage in problem-solving activities, thereby cultivating a problem-solving framework. Within mathematics instruction, problems are crafted to meet specific criteria conducive to problem-solving. These questions yield diverse outcomes in students' responses, reflecting their problem-solving aptitude, which correlates closely with their developmental stage (Nurjanah, P & Angraini, LM. 2024). Many fail to achieve the Minimum Mastery Criteria (KKM) because the learning process tends to rely on lectures and exercises without the support of appropriate media. Bruner (1966) emphasized that conceptual understanding becomes more meaningful when students experience three stages of representation: enactive (using concrete objects), iconic (using visuals), and symbolic (using mathematical symbols).

Instructional media play a crucial role in enhancing learning quality. Arsyad (2019) stated that instructional media is anything that can convey messages, stimulate students' thoughts, feelings, attention, and motivation, thereby promoting effective learning. Attractive and appropriate media can increase motivation, help students grasp abstract concepts, and create a more enjoyable learning environment (Mayer, 2009). Educational games are defined as games that help students improve their memory, enhance their creativity, and increase their ability to answer questions (Siti Aminah & Salman, 2024).

In lots of major media have been used successfully to improve learning outcomes. One of the strategies to improve the independence of study of physics student is through learning media (Sohibun & Ade, 2017). One of the instructional media applicable to fraction learning is puzzles. A puzzle is an educational game consisting of pieces of images or shapes that must be arranged into a whole. According to Hidayat (2020), puzzles can develop logical thinking skills, improve concentration, and foster learning motivation through enjoyable activities. In mathematics learning, puzzles can be adapted to specific topics, such as circle or square puzzles divided into fractional parts.

Furthermore, puzzle use aligns with the principles of active learning. Silberman (2016) emphasized that active learning requires students' direct involvement in the learning process rather than passively receiving information from teachers. Through puzzles, students are encouraged to think, discuss, collaborate, and solve problems, which makes learning more meaningful (Prince, 2004).

Based on these theoretical foundations, the use of puzzle media is considered an innovative solution to overcome difficulties in learning fractions among junior high school students. Therefore, this study aims to:

1. Describe the process of learning fractions using puzzle media.
2. Examine the improvement of mathematics learning outcomes of seventh-grade students at SMP IT Lentera after using puzzle media in learning fractions

The novelty of this study lies in the application of puzzle media as an innovative learning strategy for teaching fractions at the junior high school level. While previous research on mathematics learning has predominantly employed conventional concrete press (such as manipulatives or standard teaching aids), this study introduces puzzles that integrate elements of play and visualization. This approach not only facilitates a deeper understanding of abstract fraction concepts but also enhances student engagement and motivation. Moreover, by employing a systematic Classroom Action Research (CAR) design in two cycles, this study provides empirical evidence of the effectiveness of puzzle-based learning. Thus, it contributes to enriching the repertoire of mathematics teaching strategies and offers a fresh alternative to overcoming persistent learning difficulties in fractions.

2. Methods

2.1 Research Design

This study employed a Classroom Action Research (CAR) design. According to Arikunto (2015), CAR is conducted in the classroom to improve learning processes and outcomes through systematically planned, implemented, observed, and reflected actions. The choice of CAR was based on the real problems faced by seventh-grade students, namely, low achievement in learning fractions. Therefore, an intervention using puzzle media was introduced to enhance learning outcomes.

2.2 Participants

The participants were 30 seventh-grade students at SMP IT Lentera, Rokan Hulu Regency, consisting of 14 male and 16 female students. The study was conducted during the even semester of the 2024/2025 academic year over a period of approximately two months, covering the preparation, implementation, and reflection stages.

2.3 Research Procedures

The research was implemented in two cycles, with each cycle consisting of four stages: planning, action, observation, and reflection.

1. Planning: Lesson plans integrating puzzle media into the fraction topic were developed. Puzzle sets in the form of circles and squares divided into fractional parts were prepared, along with research instruments such as achievement tests, observation sheets, and field notes.
2. Action: The learning process was carried out according to the lesson plans. The teacher motivated students, introduced puzzle media, and organised them into small groups to solve fraction puzzles. Group discussions followed, and the teacher guided students in concluding fraction concepts.
3. Observation: Conducted simultaneously with teaching, observation focused on student engagement, enthusiasm, group collaboration, and challenges encountered. At the end of each cycle, a learning achievement test was administered.
4. Reflection: After analysing observation results and test scores, the researcher evaluated the strengths and weaknesses of the learning process. Reflection from Cycle I informed improvements for Cycle II, such as clearer instructions, smaller groups, and more intensive guidance.

2.4 Instruments

Three instruments were employed:

1. Achievement Tests – administered at the end of each cycle to measure improvement in students' understanding of fractions.
2. Observation Sheets – used to record students' activities, engagement, and participation during the lesson.
3. Field Notes – used to document additional observations and contextual aspects not captured by other instruments.

2.5 Data Analysis

Both quantitative and qualitative approaches were used. Quantitative data from achievement tests were analysed by calculating mean scores and the percentage of students achieving mastery. Qualitative data from observations and field notes were analysed narratively to describe changes in students' motivation, participation, and responses to puzzle media.

2.6 Success Indicators

The criteria for success were based on two aspects:

1. Learning Outcomes: Improvement in student performance across cycles, both in terms of class averages and mastery percentages. The criterion for classical mastery was set at 85% of students achieving the Minimum Mastery Criteria (KKM).
2. Student Engagement**:** Active participation, high enthusiasm, and positive attitudes toward the use of puzzle media in fraction learning.

3. Results and Discussion

3.1. Results

The classroom action research was conducted in two cycles, each consisting of planning, action, observation, and reflection stages. Data were obtained from learning achievement tests administered at the end of each cycle and from observations of students' activities during lessons using puzzle media.

3.1.1. Pre-Cycle Condition

Before the intervention, students' learning outcomes in fractions were relatively low. Out of 30 students, only 12 (40%) achieved the Minimum Mastery Criteria (KKM), with an average score of 60. Observations also revealed that students tended to be passive, less motivated, and struggled when solving fraction-related problems.

3.1.2. Cycle I Results

After implementing puzzle media in Cycle I, improvements were observed. The class average score increased to 72, with 20 students (66.7%) achieving mastery. Student engagement also showed positive changes; most students appeared enthusiastic when assembling fraction puzzles in groups and actively participated in discussions. However, some students remained less active and tended to rely on their peers. Reflection revealed weaknesses such as unequal participation and limited time for completing tasks. These findings were used to refine the strategy in Cycle II.

3.1.3. Cycle II Results

In Cycle II, adjustments such as smaller groups, clearer instructions, and better time management were applied. The results showed more significant improvements: the average score rose to 82, with 26 students (86.7%) meeting the KKM. Students' participation also became more evenly distributed, and previously passive students began contributing actively. The learning atmosphere became more dynamic, enjoyable, and interactive.

Table 1 - Comparison of Cycle I and Cycle II Results

Aspect	Cycle I	Cycle II
Average Score	72	82
Students Achieving Mastery (≥ KKM)	20 students (66.7%)	26 students (86.7%)
Student Engagement	Most students enthusiastic, but some were passive and relied on peers	Participation more evenly distributed; previously passive students became active
Learning Atmosphere	Positive but some weaknesses (unequal participation, limited time)	More dynamic, enjoyable, and interactive
Weaknesses Identified	Unequal participation, limited time for tasks	Addressed by forming smaller groups, clearer instructions, and better time management

3.1.4. Summary of Results

Table 1 presents a comparison of student learning outcomes across the pre-cycle, Cycle I, and Cycle II.

Table 2 - Comparison of Students' Learning Outcomes Across Cycles

Cycle	Average Score	Students Achieving Mastery	Percentage of Mastery
Pre-Cycle	60	12 out of 30	40.0%
Cycle I	72	20 out of 30	66.7%
Cycle II	82	26 out of 30	86.7%

Table 1 shows a consistent improvement in students' mathematics learning outcomes. From the pre-cycle to Cycle II, the class average increased by 22 points (from 60 to 82), and the mastery percentage improved by 46.7% (from 40.0% to 86.7%). The findings demonstrate that puzzle media effectively enhanced students' understanding of fractions. The improvements across both average scores and mastery percentages indicate the positive impact of puzzle-based learning. These results align with Bruner's theory of representation, which emphasizes that learning is more meaningful when students experience enactive (using concrete objects), iconic (using visuals), and symbolic (using mathematical symbols) stages. By engaging students in assembling and interpreting puzzles, abstract fraction concepts were translated into concrete and visual representations, thereby improving comprehension and motivation.

3.2. Result

The results of this classroom action research clearly show that the use of puzzle media in teaching fractions significantly improved students' learning outcomes. The increase in average scores, from 60 in the pre-cycle to 72 in cycle I and 82 in cycle II, together with the rise in classical mastery from 40% to 66.7% and finally to 86.7%, demonstrates that the intervention was highly effective. These findings indicate that students not only achieved the minimum mastery criteria but also demonstrated better conceptual understanding and engagement throughout the cycles.

This result is strongly supported by Bruner's theory of representation (Bruner, 1967), which posits that students learn best when moving progressively through the stages of enactive, iconic, and symbolic representation. In this study, the puzzle served as an enactive tool by providing a tangible medium for manipulating pieces, and simultaneously as an iconic tool by visually representing fractional parts. This combination allowed students to bridge their understanding from concrete experiences to abstract reasoning in symbolic mathematics. The use of puzzle media therefore played

a crucial role in reducing students' difficulties with fractions, a topic that is often challenging due to its abstract nature.

Another significant outcome of this study was the increase in students' motivation and activeness. During the lessons, students were more enthusiastic and engaged compared to conventional learning sessions. The process of assembling puzzles made learning feel like a game, stimulating curiosity and reducing anxiety towards mathematics. This finding is in line with Sari and Rahmawati (2019), who found that game-based learning media can enhance students' motivation in mathematics. Likewise, Fitriani and Hidayat (2018) reported that puzzle media helps sustain students' focus and attention, which is essential in achieving meaningful learning.

Several previous studies reinforce these findings. Prawismo et al. (2022) demonstrated that puzzle media facilitated students in lower elementary grades to better understand fractions through concrete representation. Similarly, Putri and Ningsih (2022) highlighted that puzzle media transforms abstract mathematical concepts into more accessible and meaningful learning experiences. Research by Wisesa and Widyaningrum (2024) also showed gradual improvement in student achievement through the use of puzzle media across cycles of classroom action research, with mastery learning levels rising in a pattern similar to the present study.

In addition to cognitive outcomes, puzzle media contributed to collaborative and interactive learning environments. Students were observed to discuss, negotiate, and cooperate while assembling puzzles, which enhanced their social and communication skills. This aspect supports the findings of those who demonstrated that mission-based puzzle learning improved not only problem-solving skills but also collaboration among students. Similarly, the study on problem-based learning with puzzle support (Fraktal, 2024) confirmed that puzzles encourage active participation and cooperative learning behaviors.

The affective benefits of using puzzle media are equally important. Annisa and Sunedi (2022) found that puzzle media significantly improved average scores in mathematics learning and made students more confident in solving problems. In line with this, the implementation of Course Review Horay integrated with puzzle media (Improving Fraction Learning Using Course Review Horay and Puzzle Media, 2025) proved that students' activeness, enjoyment, and motivation can be simultaneously enhanced when puzzles are used in classroom practice. These studies collectively strengthen the conclusion that puzzle media is not only a tool for improving test scores but also a catalyst for positive learning attitudes.

Overall, the present findings provide evidence that puzzle media serves multiple functions in mathematics education. Cognitively, it supports students in transitioning from concrete to abstract reasoning in fractions, which is consistent with Bruner's theoretical framework. Affectively, it reduces students' negative perceptions of mathematics by making the learning process fun, engaging, and less intimidating. Socially, it fosters collaboration and communication skills that are increasingly valued in 21st-century education. Therefore, puzzle media can be considered an effective and holistic instructional strategy in mathematics classrooms.

The implications of this study are twofold. First, teachers should integrate puzzle-based activities into the teaching of abstract mathematical topics such as fractions to make learning more accessible and enjoyable. Second, puzzle media can be further combined with innovative models such as problem-based learning or cooperative learning to maximize its benefits. This integration will not only improve academic achievement but also cultivate soft skills such as teamwork, persistence, and critical thinking. Future research may explore the use of digital puzzles or technology-enhanced puzzle media,

as suggested by current trends in educational technology, to further enhance students' learning experiences in mathematics.

4. Conclusions

This classroom action research concludes that puzzle-based learning significantly improved students' understanding of fractions in grade VII. The average scores increased from 60 in the pre-cycle to 72 in cycle I, and then to 82 in cycle II. Likewise, mastery learning improved from 40% in the pre-cycle to 66.7% in cycle I, and finally reached 86.7% in cycle II. Beyond cognitive gains, puzzle-based learning enhanced students' activeness, motivation, and collaboration. Students were more engaged, enthusiastic, and willing to contribute to group discussions, making the learning process both effective and enjoyable. In line with previous studies, these findings confirm that puzzle media can serve as an effective instructional tool for teaching abstract mathematical concepts. Teachers are encouraged to integrate puzzle-based activities into mathematics instruction to foster deeper understanding and greater motivation among students.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this research article.

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