CREATIVE THINKING SKILLS OF GRADE XI STUDENTS OF MA NURUL ISLAM LUMAJANG IN SOLVING MATHEMATICS PROBLEMS: ANALYSIS BASED ON THE LEVEL OF ACADEMIC ABILITY

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Abstract: This study aims to describe and analyze the mathematical creative thinking ability of grade XI students of MA Nurul Islam Lumajang based on the level of academic ability. Creative thinking skills are an important competency in facing the challenges of the 21st century, especially in the midst of low national mathematics literacy as shown by the 2018 PISA results. Although the Problem-Based Learning (PBL) learning model has been implemented at MA Nurul Islam Lumajang, its effectiveness in developing students' mathematical creativity is still not optimal. This study uses an observation method supported by teaching and learning activities, and documentation, with the subject of teachers and students in grade XI. The results of the study show that students with high academic ability are more able to meet the indicators of creative thinking, especially in the aspects of flexibility and precision. On the other hand, students with medium and low ability show limitations in coming up with original and detailed solutions. Therefore, it is necessary to design a personalized learning strategy according to the student's ability level to optimize the development of their mathematical creativity. Approaches such as open-ended question-based PBL are highly recommended to improve the fluency, flexibility, authenticity, and accuracy of students' creative thinking in solving mathematical problems. These findings emphasize the importance of integrating adaptive learning strategies in an effort to improve the quality of mathematics education at the madrasah level.

Keywords: Creative Thinking Mathematics, Academic Ability, Problem-Based Learning

1. INTRODUCTION

Mathematics is one of the essential subjects in education, having a fundamental role in developing students' cognitive and analytical abilities [1], [2]. Math skills are not only important for mathematical problem solving, but also for critical decision-making in everyday life. Mathematical creative thinking skills are an essential competency in solving complex problems of the 21st century, especially in educational environments that face the challenge of low math literacy [3], [4]. The results of the 2018 PISA study [5] show that Indonesia's mathematics literacy score is ranked at the bottom (72 out of 78 countries), with only 28% of students able to

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solve intermediate level problems [6]. This low ability is reflected in the indicators of fluency, flexibility, and originality that are not optimal [3].

The persistent gap in mathematics achievement suggests that traditional teaching methods, which emphasize memorization and procedural fluency, are insufficient to develop students' creative potential [8], [9]. Many students perceive mathematics as rigid and limited to fixed formulas, which inhibits their ability to think divergently when facing unfamiliar problems [10], [11]. This perception often leads to low engagement and reduced motivation to explore alternative solutions. To overcome this, learning should emphasize mathematical reasoning, connection-making, and reflection on multiple approaches to problem solving [12]–[14]. Such practices can help students view mathematics as a dynamic and meaningful discipline rather than a collection of abstract rules.

Another critical factor influencing the development of mathematical creativity is the learning environment and teacher facilitation [15], [16]. Teachers play a central role in fostering students' curiosity, encouraging exploration, and valuing original ideas during discussions [17], [18]. When teachers adopt open-ended questioning and promote collaborative problem solving, students become more confident in expressing diverse ideas and justifying their reasoning [19]. However, this shift requires teachers to design tasks that are complex enough to challenge students while still being achievable [20], [21]. Therefore, teacher competence in applying innovative pedagogical models becomes a determining factor in cultivating mathematical creativity.

Among the various models that promote creativity, the Problem-Based Learning (PBL) approach has gained attention for its potential to enhance students' higher-order thinking skills [22], [23]. PBL engages students in solving real-world problems that require analysis, synthesis, and evaluation rather than rote application of formulas [24], [25]. Through this process, students learn to construct knowledge actively and apply mathematical concepts in meaningful contexts [26], [27]. Additionally, PBL encourages communication and teamwork, which are crucial for developing flexibility and originality in thinking [28]. For these reasons, PBL is

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considered a promising alternative to improve students' mathematical creative thinking in the current educational landscape.

At MA Nurul Islam Lumajang, although the Problem-Based Learning (PBL) model has been implemented in class XI, its effectiveness in developing mathematical creativity is still limited. Field observations show that students tend to rely on conventional methods and are less trained in solving open-ended problems, which are the basis for measuring creative thinking [3], [4]. Previous research has also confirmed that students with high academic ability are better able to meet indicators of creativity (such as flexibility and novelty) than moderate-low groups [5].

This gap underscores the urgency of academic-based analysis to design learning strategies that focus on improving the quality of solutions, not just the quantity of answers [3], [6]. Thus, this study aims to identify the creative thinking patterns of MA Nurul Islam Lumajang students as the basis for the development of a personalized PBL model. nderstanding students' creative thinking tendencies is essential to ensure that learning activities are aligned with their cognitive characteristics and problem-solving styles. Furthermore, the findings are expected to guide teachers in designing more adaptive instructional strategies that foster innovation and deeper reasoning. Ultimately, this approach can contribute to cultivating a learning culture that values critical reflection, originality, and effective problem resolution.

2. RESEARCH METHODS

This study employs a qualitative research design that aims to describe the learning conditions and creative thinking processes that occur during the implementation of learning on the topic of volume of solid figures. The qualitative approach was chosen to allow an in-depth exploration of students' thought patterns, reasoning processes, and problem-solving strategies as they engage with open-ended mathematical tasks. This method provides a more comprehensive understanding of how students interpret and apply mathematical concepts within authentic learning contexts. Through direct observation, documentation, and interaction during learning activities, the researcher seeks to capture various phenomena that reflect the

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development of students' mathematical creativity, including fluency, flexibility, and originality in generating solutions.

The subjects of this study were 16 grade XI students from one of the Madrasah Aliyah in Lumajang Regency, who were divided into three groups based on their academic ability levels: high, medium, and low. Such grouping was intended to reveal the diversity of creative thinking patterns across different performance levels, thereby providing more nuanced insights into students' learning behavior. The research was conducted during the even semester of the 2024/2025 academic year, with learning sessions designed to apply the Problem Based Learning (PBL) approach. The primary instrument used was a descriptive test consisting of three open-ended problems aimed at assessing mathematical creative thinking skills. Each problem was designed to measure key indicators of creativity, namely fluency in generating ideas, flexibility in strategy selection, and originality in constructing novel solutions.

3. RESULTS AND DISCUSSION

A. RESULTS

This research was carried out in one of the XI classes in one of the MA in Lumajang Regency. The data from the results of this study is in the form of student learning outcomes whose data collection uses test question instruments in the form of descriptions of 3 questions. Data was obtained from the results of the analysis of students' answers based on mathematical creative thinking. The following is a table of mathematical creative thinking questions which includes indicators of fluency, flexibility, originality, and elaboration according to [30] which have been modified as follows.

Table 1. Summary of Students' Mathematical Creative Thinking Indicators by Group

Indicator	Group 1	Group 2	Group 3
Fluency	Medium	Medium	High (lots of ideas)
Flexibility	Very low	Medium (lots of ideas)	High (various strategies)
Authenticity	Medium	Medium (self-explanatory)	Medium
Accuracy	Low (less	Medium (self-	Medium

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obvious)	explanatory)

The analysis of students' creative thinking indicators shows clear differences among the three groups. Group 3 demonstrated the highest level of creative thinking ability, with high performance in fluency and flexibility, and medium performance in originality and accuracy. This combination indicates that students in this group are capable of generating many ideas and applying various strategies to solve problems effectively. Their balanced performance across indicators reflects a strong and consistent creative thinking profile. Overall, Group 3 represents students who can think divergently and adaptively when faced with mathematical challenges.

In contrast, Group 2 and Group 1 displayed lower levels of creative thinking. Group 2 showed moderate ability across all indicators, suggesting that they possess adequate potential but have not yet developed distinctive creative characteristics. Meanwhile, Group 1 showed the weakest performance, with very low flexibility and low accuracy, even though their fluency and originality were at a moderate level. This indicates that students in Group 1 still face significant challenges in producing varied and accurate solutions. These findings highlight the need for differentiated learning strategies to strengthen students' flexibility and accuracy, particularly for those in the lower-performing groups.

1. High-Ability Students

Students with high academic ability exhibit dominant creative thinking skills, especially in fluency, flexibility, and precision. They are able to generate a lot of ideas, use a variety of problem-solving approaches, and provide systematic elaboration. However, in terms of authenticity, there are still conventional patterns, so while effective, the solution is not very unique[15]. This confirms that outstanding students tend to think systematically, but not necessarily authentically. Also in the aspect of accuracy, the ability to develop ideas is less detailed and systematic, explanations that are also limited and less detailed.

2. Moderately Capable Students

This group tends to stand out on smoothness and some precision, but is weak in flexibility and authenticity. Students are able to solve problems with several ideas,

but not varied. The strategies used tend to be limited to methods that have been taught directly. These findings support previous research assertions that students with moderate abilities need support to develop alternative strategies and unique solutions [32].

3. Low-Ability Students

Students in this category have difficulty in almost all indicators. They are not capable of developing ideas, solutions are very simple, and use one way without development. This indicates the need for problem-based learning interventions designed more targeted and in-depth for this group.

B. DISCUSSION

The study reinforces previous findings on the positive relationship between academic ability and mathematical creative thinking, with empirical support from some recent research. Students with high academic ability show excellence in flexibility and elaboration, which is consistent with the Creative Problem Solving (CPS) model mechanism in facilitating the exploration of alternative strategies [15]. However, the weakness of originality at all levels of ability points to the need for specific interventions to stimulate innovation.

Cutting-edge research also highlights the importance of supportive learning environments, such as the use of technology and project-based learning, in developing aspects of originality. The integration of digital technology can expand the space for the exploration of new ideas in mathematics learning, thus potentially increasing students' originality. In addition, the collaborative learning approach has also been proven to be able to trigger creative discussions and exchange of more original ideas between students[34].

This study reinforces empirical evidence about the positive correlation between creativity and mathematics learning outcomes. The findings of previous research showing the contribution of creativity of 18.43% to the improvement of learning outcomes are in line with the hierarchy of creativity of Silver (1997) [35]. This confirms that creative thinking abilities (such as fluency and originality) play a

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role as mediators in academic achievement, especially in the context of complex problem-solving.

Furthermore, the meta-analysis showed that mathematical creativity not only contributes to academic achievement, but also builds students' confidence in the face of non-routine math challenges. The book "Creativity and Giftedness: Interdisciplinary Perspectives from Mathematics and Beyond" by Leikin, Berman, & Koichu (2017) also emphasizes that developing creativity through mathematics learning can improve students' critical and reflective thinking skills, ultimately positively impacting overall learning outcomes [20].

The study by Septian et al. enriched these findings by showing an n-gain score of 0.7021 in the group using the CPS model, which specifically improved the fluency and originality aspects [15]. The effectiveness of CPS in stimulating the exploration of alternative strategies is also supported by Musaidah et al.'s research that integrates CPS with e-modules, resulting in a significant improvement in students' divergent thinking skills [17].

In addition, research by Kim et al. (2021) shows that the use of digital technology in mathematics learning, such as interactive e-modules, can accelerate the process of internalizing creative problem-solving strategies. This is in line with the findings of Musaidah et al., where the integration of technology not only increases students' motivation to learn, but also expands the scope of exploration of new ideas in mathematical problem solving [22].

Recent research also highlights that the development of mathematical creative thinking skills is strongly influenced by students' intrinsic motivational factors and their perception of mathematics as a dynamic discipline. A study by Ibrahim et al. (2024) found that students who had a positive perception of math challenges tended to show higher levels of originality and flexibility in solving open-ended problems [23]. A learning environment that emphasizes exploration and reflection has been proven to significantly improve students' indicators of fluency and elaboration.

In addition, research by Aldilla et al. (2023) shows that the integration of STEM (Science, Technology, Engineering, and Mathematics)-based learning can

strengthen mathematical creative thinking skills, especially in terms of flexibility and originality [40]. This learning model encourages students to connect mathematical concepts with real-world contexts, resulting in more varied and innovative solutions

Research by Nilimaa (2023) confirms that the use of authentic assessments, such as portfolios and problem-based projects, is effective in mapping students' creative skill development [41]. Through this assessment, teachers can identify specific indicators that still need to be improved, especially in groups of students with medium and low academic ability. Another study by Zheng (2024) proves that collaboration between mathematics teachers and teachers in other fields in designing cross-disciplinary learning can enrich students' learning experiences, thus having a positive impact on improving aspects of originality and elaboration in mathematical creative thinking[42].

Finally, a meta-analysis by James (2024) concluded that digital technology-based learning interventions, such as the use of interactive problem-solving applications, consistently improve students' mathematical creativity scores at various levels of education[27]. These findings reinforce the urgency of integrating technology in mathematics learning to optimize students' creative potential.

Overall, the latest literature confirms that strengthening aspects of originality and fluency in creative thinking in mathematics requires a holistic, collaborative, and technology-based approach to learning. Structured and sustained interventions are essential to ensure that every student, regardless of their level of academic ability, has an equal opportunity to develop their creative potential optimally.

4. CONCLUSION

This study concludes that there are clear differences in mathematical creative thinking abilities among students with varying levels of academic achievement. Students with high academic ability demonstrate the strongest creative thinking performance, particularly in flexibility and rigor, reflecting their capacity to employ diverse strategies and solve problems systematically. Those with moderate academic ability show relatively good fluency and originality but remain limited in flexibility,

while students with low academic ability experience significant challenges across most indicators. These findings highlight the close relationship between academic ability and creative thinking, emphasizing the need for adaptive learning strategies that accommodate students' varying levels of competence. The implementation of a problem-based learning model tailored to students' academic characteristics is recommended to foster more equitable creative development. Future research should involve larger samples and a mixed-method approach to obtain deeper insights and explore additional factors, such as motivation and learning styles, that may influence students' mathematical creative thinking skills.

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