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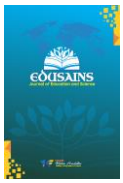

# Mathematical Creative Thinking Ability of Eighth-Grade Students at an Indonesian Islamic Boarding School: An Indicator-Based Descriptive Study

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**A B S T R A C T**

Mathematical creative thinking is an essential higher-order competence, yet profiles of this ability among students in Indonesian Islamic boarding schools (pesantren) are rarely reported. This descriptive quantitative study examined the creative thinking levels (TKBK) and indicator profile of 26 eighth-grade students at Ashhabul Yamin Islamic Boarding School, selected through purposive sampling. Data were collected with a four-item essay test on circles, in which each item targeted one indicator (fluency, flexibility, originality, or elaboration) and was scored from 0 to 4, and were analysed descriptively. The largest proportion of students was moderately creative (38%), followed by creative (31%), less creative (27%), and not creative (4%); none were highly creative. Originality was the strongest indicator (M = 3.15 out of 4) and fluency the weakest (M = 1.81). The students generally solved problems correctly but rarely generated multiple ideas or methods, which indicates a need for regular open-ended and problem-posing tasks that require more than one solution.

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## 1. Introduction

Creative thinking is widely regarded as a core competence that students need in order to respond to rapid scientific and technological change and to increasingly complex global demands (Hendriana & others, 2018). In mathematics, creative thinking is the process of generating new ideas, approaches, or solutions to a problem (Hadar & Tirosh, 2019; Margaretha & Hidayat, 2023). Mathematical creative thinking is therefore an essential ability that should be developed in every student who learns mathematics (Br Ginting et al., 2025; Istikomah & Supriyadi, 2024) and treated as an integral part of mathematics curriculum design from the early grades (Bicer et al., 2024; Hanifah et al., 2025). This ability enables students to produce a variety of ideas and to find alternative solutions when they encounter mathematical problems (Saputra et al., 2024), and research on mathematical creativity has expanded considerably in recent years (Yudha & Rosnawati, 2025).

Krulik classifies thinking into four levels, namely recall, basic, critical, and creative thinking, of which critical and creative thinking are regarded as higher-order abilities (Suharna, 2018). Higher-order thinking involves the deep cognitive activity required to handle new or non-routine tasks and corresponds to the highest levels of the cognitive process taxonomy, namely analysing, evaluating, and creating (Djidu & Jailani, 2017). Operationally, mathematical creative thinking ability is the ability to solve mathematical problems by

proposing new ideas that are based on one's own reasoning and are understandable to others (Aniswita et al., 2021; Yanti et al., 2025). It is commonly assessed through four indicators: *fluency*, the ability to generate many relevant ideas or answers; *flexibility*, the ability to use different approaches or viewpoints; *originality*, the ability to produce unusual or self-generated solutions; and *elaboration*, the ability to develop an idea in detail (Fatmala & Kusno, 2023; Firdausi et al., 2021). On the basis of how these indicators are fulfilled, students can further be classified into creative thinking levels (*tingkat kemampuan berpikir kreatif*, TKBK) ranging from not creative to highly creative (Kholid et al., 2024). According to Siswono (2011), creative thinking ability is classified into five levels: level 0 (not creative), level 1 (almost not creative), level 2 (quite creative), level 3 (creative), and level 4 (very creative) (Siswono, 2011).

A growing body of Indonesian research has profiled the mathematical creative thinking of junior high school students. Previous studies have described the creative thinking and numeracy of eighth-grade students in a public junior high school using the same four indicators (Nasruddin & Jahring, 2024), students' creative thinking on angles, triangles, and geometry content (Bahagia et al., 2022; Kadir et al., 2022; Nurhanifah, 2022), and the creative thinking of seventh-grade students solving open-ended plane geometry problems, examined through tests and interviews (Ardiansyah et al., 2025), as well as related work on linear inequalities and fractions (Aulia et al., 2025; Hanifah et al., 2025). Open-ended problem-solving tests have been shown to capture both the products and the processes of students' mathematical creativity (Rahayuningsih et al., 2021), and creative thinking has been associated with students' thinking styles and self-efficacy (Fitriana et al., 2020; Rahayuningsih et al., 2022) and with the ways they approach non-routine problems (Kholid et al., 2024). However, most of these studies were conducted in regular schools, and several relied on qualitative designs with a small number of participants. Whole-class profiles that report all four indicators for students in Islamic boarding schools (*pondok pesantren*) therefore remain scarce.

Various instructional approaches have been proposed to foster mathematical creative thinking, including problem-solving and problem-based learning (Hendriana & Fadhillah, 2019; Khalda et al., 2023), open-ended tasks and the modification of closed problems into open-ended ones (Desi et al., 2025; Lestari et al., 2025; Septiani et al., 2022), problem posing (Aba et al., 2021; Rahmaini et al., 2024), creative problem solving and the Treffinger model (Gumilar & Syahpitri, 2026; Saputra et al., 2024), flipped classrooms (Zakiyah et al., 2023), project-based cooperative learning (Afrilianto, 2022), realistic mathematics education (Wulandari et al., 2023), ethnomathematics (Arion & Rosita, 2024), multiple representations (Bicer, 2021), and digital problem-posing tools (Bani & Angkotasan, 2026). Selecting an appropriate approach, however, requires a prior diagnosis of which aspects of creative thinking are weak in a particular group of students.

Islamic boarding schools typically combine the national curriculum with intensive religious education. Observations conducted by the authors at Ashhabul Yamin Islamic Boarding School revealed a gap between current mathematics instruction and the need to develop students' creativity. Mathematics lessons tended to focus on the conventional delivery of content and on routine exercises, offering students few opportunities to propose their own ideas or alternative solutions, and teachers had a limited understanding of the importance of creativity in mathematics learning. As a result, students' creative thinking potential has not been optimally facilitated. Students' mathematics achievement also varied

considerably across classes, as shown by the mastery percentages of the eighth-grade mathematics quiz in Table 1.

**Table 1.** Mastery Percentages of the Eighth-Grade Mathematics Quiz
Ashhabul Yamin Islamic Boarding School

| Class | Number of students | KKM | Passed | Not Passed | Percentage | |
|---|---|---|---|---|---|---|
| | | | | | Passed (%) | Not Passed (%) |
| VIII.1 | 31 | 75 | 22 | 9 | 71% | 29% |
| VIII.2 | 27 | | 10 | 17 | 37% | 63% |
| VIII.3 | 27 | | 6 | 21 | 22% | 78% |
| VIII.4 | 26 | | 16 | 10 | 62% | 38% |
| VIII.5 | 21 | | 4 | 17 | 19% | 81% |

Table 1 shows that only two of the five classes reached a mastery rate above 50%, meaning that most students in the remaining classes scored below the Minimum Mastery Criterion (KKM = 75). Class VIII.1 had the highest mastery rate (71%). A high quiz mastery rate, however, does not necessarily reflect creative thinking. Preliminary data on the creative thinking levels of the students in Class VIII.1 were obtained through a creative thinking quiz administered on January 21, 2026. The result showed that most of them were at the moderately creative or less creative level (Table 2).

**Table 2.** Preliminary Creative Thinking Levels of Class VIII.1 Students
Ashhabul Yamin Islamic Boarding School

| Class | Number of Students | Highly Creative | Creative | Moderately Creative | Less Creative | Not Creative |
|---|---|---|---|---|---|---|
| VIII.1 | 26 | 0 | 2 | 9 | 12 | 3 |
| Proportion | | 0.00 | 0.08 | 0.35 | 0.46 | 0.12 |
| Percentage | | 0% | 8% | 35% | 46% | 12% |

Table 2 indicates that, despite having the highest quiz mastery rate, Class VIII.1 was dominated by students at the moderately creative and less creative levels (81%), and no student was at the highly creative level. A detailed, indicator-level profile of these students is therefore needed before appropriate instructional interventions can be designed. Accordingly, this study aimed to describe the mathematical creative thinking ability of eighth-grade students at Ashhabul Yamin Islamic Boarding School by addressing two research questions: (1) How are the students distributed across the creative thinking levels (TKBK)? (2) To what extent do the students fulfil each indicator of mathematical creative thinking, namely fluency, flexibility, originality, and elaboration? The study contributes a baseline profile from a pesantren setting, which has received limited attention in previous research, and identifies the indicators that most require instructional support.

## 2. Method

### 2.1. *Research Design*

This study employed a descriptive quantitative design (Bahagia et al., 2022). Descriptive quantitative research describes existing conditions systematically, factually, and accurately on the basis of numerical data, without manipulating any variables (Yusuf, n.d.). This design was chosen because the study aimed to describe the level and indicator profile of students' mathematical creative thinking rather than to test the effect of an intervention. Because the

data consisted of students' written answers, the analysis concerns the products of creative thinking rather than the underlying thinking processes.

### 2.2. *Setting and Participants*

The study was conducted at Ashhabul Yamin Islamic Boarding School, an Islamic junior high school (SMP) located in Nagari Lasi, Canduang District, Agam Regency, West Sumatra, Indonesia, during the second semester of the 2025/2026 academic year.. The participants were 26 students of Class VIII.1, selected through purposive sampling, that is, the selection of participants on the basis of specific considerations (Aulia et al., 2025; Rahayuningsih et al., 2021). Class VIII.1 was selected because it had the highest mastery rate on the eighth-grade mathematics quiz (Table 1), so its profile indicates the highest level that can be expected among the eighth-grade classes. Of the 31 students enrolled in Class VIII.1, 26 participated in the study, while five students were unable to participate because they were absent on the day of data collection. The participants ranged in age from 13 to 15 years.

### 2.3. *Instrument*

The instrument was an essay test consisting of four items on circles, following previous studies that used essay tests to assess creative thinking (Afrilianto, 2022). Each item was designed to elicit one indicator: Item 1 (fluency) asked for the minimum length of ribbon needed to cover the radii, a chord, and the apothem of a circle; Item 2 (originality) asked for the area of a 30° sector of a circle with a radius of 21 cm; Item 3 (flexibility) asked for the length of an arc with a 60° central angle and a radius of 14 cm, to be solved in two ways; and Item 4 (elaboration) asked for the area of a 90° sector of a circle with a radius of 28 cm, to be solved in a different way. The items were presented in Indonesian, the language of instruction (see Figures 1–4).

Each answer was scored on a 0–4 scale, so the total score ranged from 0 to 16. A score of 4 was given when the response fully met the indicator with a complete and correct solution; 3 when it met the indicator with minor errors; 2 when it partially met the indicator; 1 when the student attempted the item but did not meet the indicator; and 0 when there was no answer or the answer was irrelevant.

The content validity of the quiz items was established through expert judgment by three expert lecturers. The validation was conducted using an expert validation sheet to assess the relevance and suitability of the items for measuring students' creative thinking ability. Revisions were made based on the experts' feedback and suggestions. After the revision process, the quiz items were declared valid and suitable for use in data collection.

### 2.4. *Data Collection Procedure*

The test was administered on march 10, 2026,during a regular methematics lesson lasting 90 minutes. Students worked individually without assistance. The students' answer sheets were assessed and scored by the first author. All responses were evaluated by the same examiner to ensure consistency in the scoring process.

### 2.5. *Data Analysis*

The data were analysed using descriptive statistics. For each item and for the total score, the mean, standard deviation, lowest score, highest score, and percentage of the maximum score were calculated. At the item level, scores of 4, 3, 2, 1, and 0 were interpreted as highly creative, creative, moderately creative, less creative, and not creative, respectively, for the

indicator concerned. Each student's overall level was then classified into five categories: TKBK 4 (highly creative), TKBK 3 (creative), TKBK 2 (moderately creative), TKBK 1 (less creative), and TKBK 0 (not creative). The percentage of students in each category was calculated as P = (f/n) × 100%, where f is the frequency in the category and n is the number of students (n = 26). The internal consistency of the total score was estimated with Cronbach's alpha, computed from the item and total-score variances.

### 2.6. *Ethical Considerations*

Permission to conduct the study was obtained from the management of Ashhabul Yamin Islamic Boarding School. The confidentiality of students' identities was maintained throughout the research process. Any personal identifiers in the answer sheets presented in Figures 1–4 were concealed to protect the students' privacy.

## 3. Results

### 3.1. *Descriptive Statistics of Test Scores*

Table 4 presents the descriptive statistics of the students' scores on each item and on the whole test.

**Table 4.** Descriptive Statistics of the Creative Thinking Test Scores of Class VIII.1 Students (n = 26) Ashhabul Yamin Islamic Boarding School

| Measure | Item 1 (Fluency) | Item 2 (Originality) | Item 3 (Flexibility) | Item 4 (Elaboration) | Total |
|---|---|---|---|---|---|
| Mean | 1.81 | 3.15 | 2.27 | 2.31 | 9.54 |
| Lowest score | 0 | 0 | 0 | 0 | 3 |
| Highest score | 4 | 4 | 4 | 4 | 15 |
| Maximum score | 4 | 4 | 4 | 4 | 16 |
| Sum (ΣX) | 47 | 82 | 59 | 60 | 248 |
| Standard deviation | 1.36 | 1.05 | 1.48 | 1.23 | 2.92 |
| % of maximum score | 45.2 | 78.8 | 56.7 | 57.7 | 59.6 |

As shown in Table 3, the mean total score was 9.54 out of a maximum of 16 (SD = 2.92), or 59.6% of the maximum score, and individual total scores ranged from 3 to 15. Originality (Item 2) was the strongest indicator (M = 3.15; 78.8% of the maximum), whereas fluency (Item 1) was the weakest (M = 1.81; 45.2%). Flexibility (Item 3; M = 2.27) and elaboration (Item 4; M = 2.31) were at an intermediate level. Every item produced the full range of scores from 0 to 4. The internal consistency of the total score was low (Cronbach's α = 0.29). This is partly expected because each item was designed to measure a different indicator, but it means that the overall classification should be interpreted with caution.

### 3.2. *Creative Thinking Levels*

The distribution of the students across the creative thinking levels (TKBK) is presented in Table 4.

**Table 4.** Number and Percentage of Students at Each Creative Thinking Level (TKBK)

| | Creative thinking level (TKBK) | | | | |
|---|---|---|---|---|---|
| | Highly Creative | Creative | Moderately Creative | Less Creative | Not Creative |
| Number | 0 | 8 | 10 | 7 | 1 |

| | Creative thinking level (TKBK) | | | | |
|---|---|---|---|---|---|
| | **Highly Creative** | **Creative** | **Moderately Creative** | **Less Creative** | **Not Creative** |
| Percentage | 0% | 31% | 38% | 27% | 4% |

Table 4 shows that the largest group of students (10 of 26; 38%) was at TKBK 2 (moderately creative), followed by TKBK 3 (creative; 8 students, 31%), TKBK 1 (less creative; 7 students, 27%), and TKBK 0 (not creative; 1 student, 4%). No student reached TKBK 4 (highly creative). Thus, 69% of the students were at the moderately creative level or above, whereas almost one third (31%) were at the less creative or not creative level.

### 3.3. *Creative Thinking Profile by Indicator*

To examine how each indicator was fulfilled, each item score was interpreted as a level for the corresponding indicator. Table 5 presents the distribution of the students across these levels for each item.

**Table 5.** Distribution of Students across Levels for Each Indicator (n = 26)

| Item (indicator) | Mean | Highly Creative (4) | Creative (3) | Moderately Creative (2) | Less Creative (1) | Not Creative (0) |
|---|---|---|---|---|---|---|
| Item 1 (Fluency) | 1.81 | 3 (12%) | 5 (19%) | 9 (35%) | 2 (8%) | 7 (27%) |
| Item 2 (Originality) | 3.15 | 12 (46%) | 9 (35%) | 3 (12%) | 1 (4%) | 1 (4%) |
| Item 3 (Flexibility) | 2.27 | 7 (27%) | 5 (19%) | 8 (31%) | 0 (0%) | 6 (23%) |
| Item 4 (Elaboration) | 2.31 | 7 (27%) | 1 (4%) | 13 (50%) | 3 (12%) | 2 (8%) |

Table 5 shows that fluency was the least developed indicator: only 8 students (31%) obtained a score of 3 or 4 on Item 1, whereas 7 students (27%) were not creative and 2 students (8%) were less creative on this item. In contrast, 21 students (81%) were creative or highly creative on the originality item (Item 2), and only 2 students (8%) scored below the moderately creative level.

The flexibility item (Item 3) produced the most polarised distribution: 12 students (46%) were creative or highly creative, 8 students (31%) were moderately creative, and 6 students (23%) were not creative, with no student at the less creative level. On the elaboration item (Item 4), half of the students (13; 50%) were moderately creative, 8 students (31%) were creative or highly creative, and 5 students (19%) were less creative or not creative.

### 3.4. *Examples of Student Responses*

Figures 1–4 present a typical student response for each indicator, illustrating how the scores described above appeared in the students' written work.

3.4.1. *Fluency (Item 1)*

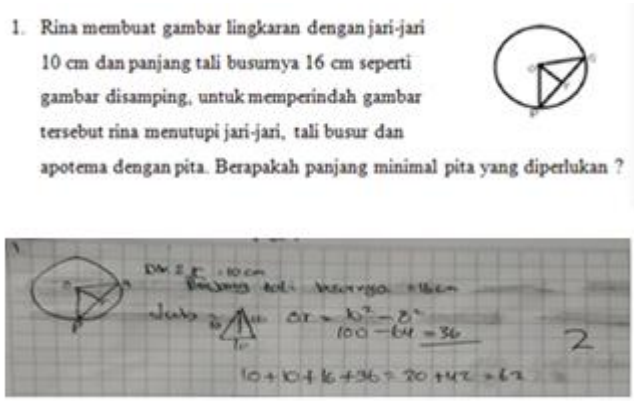


**Figure 1.** Item 1 (fluency) and a student's response (score 2)

In the response in Figure 1, the student correctly identified the given information and used the Pythagorean theorem to find the apothem, but wrote $OT^2 = 10^2 - 8^2 = 36$ and then used 36 instead of 6 as the length of the apothem, obtaining 62 cm instead of 42 cm. The student presented only one solution path and did not generate alternative ideas or answers, so the response was scored 2 (moderately creative). Responses of this kind were common on Item 1, where students tended to stop after producing a single answer.

3.4.2. *Flexibility (Item 3)*

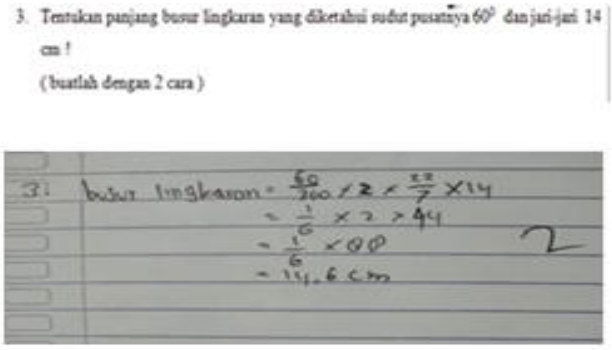


**Figure 2.** Item 3 (flexibility) and a student's response (score 2)

Item 3 explicitly asked students to determine the arc length in two ways. The student in Figure 2 applied the arc-length formula correctly ($60/360 \times 2 \times 22/7 \times 14 \approx 14.67$ cm) but used only one method. Because the student did not approach the problem from a different perspective or change the solution strategy, the response was scored 2.

3.4.3. *Originality (Item 2)*

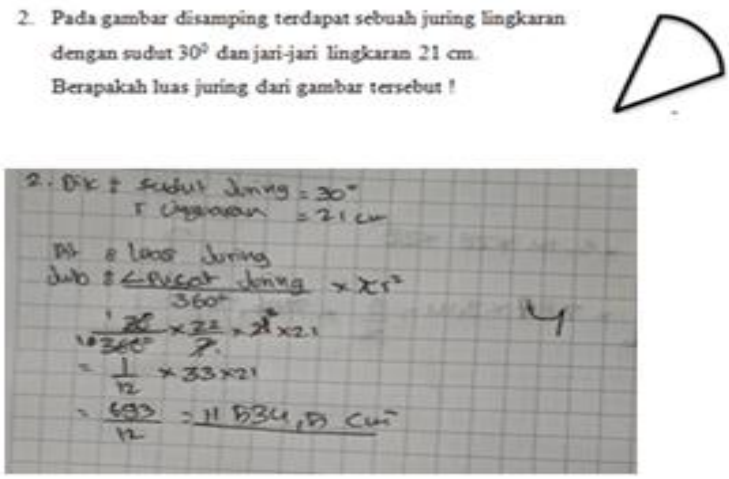


**Figure 3.** Item 2 (originality) and a student's response (score 4)

The student in Figure 3 provided a complete solution to the sector-area problem, including the known and unknown quantities, the formula, and all computational steps, and was awarded the maximum score of 4 (highly creative). Most students performed well on this item, with 81% at the creative or highly creative level.

3.4.4. *Elaboration (Item 4)*

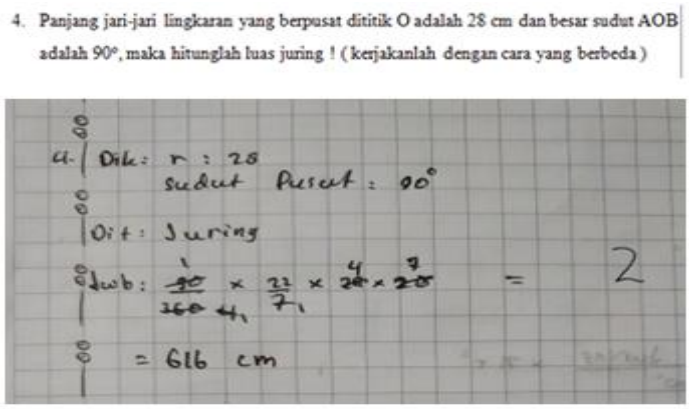


**Figure 4.** Item 4 (elaboration) and a student's response (score 2)

In Figure 4, the student obtained the correct value (616) for the area of the 90° sector but did not state the unit (cm²), did not develop the solution in detail, and did not provide a different method as requested. The response was therefore scored 2 (moderately creative).

## 4. Discussion

This study set out to describe the distribution of creative thinking levels and the fulfilment of each indicator among eighth-grade students in a pesantren setting. With regard to the first research question, the students were concentrated at the moderately creative level, and none reached the highly creative level, even though the participating class had the highest quiz mastery rate among the eighth-grade classes. This suggests that mastery of routine content, as measured by the quiz, does not automatically translate into creative thinking. The finding is consistent with reports that the mathematical creativity of Indonesian students is still low and that students are rarely accustomed to solving open-ended problems (Lestari et al., 2025).

With regard to the second research question, the indicator profile was uneven: originality was the strongest indicator and fluency the weakest. One plausible explanation lies in the

nature of the items. Item 2, which assessed originality, could be solved directly with the sector-area formula taught in class, whereas Items 1, 3, and 4 required students either to combine several concepts or to produce more than one method. The high originality scores may therefore partly reflect routine procedural competence rather than genuinely original ideas, while the low fluency and flexibility scores show that students rarely generated several answers or strategies. This interpretation is in line with the observation that classroom instruction emphasised routine exercises with a single expected answer. Because each indicator was measured by a single item, however, differences between indicators cannot be separated from differences in item difficulty. Previous studies have emphasised that fluency, flexibility, and novelty are best examined using several open-ended tasks together with students' solution processes (Ardiansyah et al., 2025; Rahayuningsih et al., 2021).

These findings have practical implications for mathematics teaching in pesantren. Because fluency and flexibility were the weakest indicators, teachers could routinely assign open-ended problems and tasks that explicitly ask for several answers or methods (Lestari et al., 2025; Septiani et al., 2022), use problem posing (Aba et al., 2021; Bani & Angkotasan, 2026), and apply models such as problem-based learning or creative problem solving, which have been reported to foster creative thinking (Khalda et al., 2023; Saputra et al., 2024). Such tasks can be embedded in existing lessons, for example by asking students to solve a textbook problem in a second way or to pose a related problem of their own.

This study has several limitations. It involved a single, purposively selected class with the highest quiz mastery rate, so the findings cannot be generalised to all students of the school or to other pesantren. Each indicator was measured by one item, and the internal consistency of the total score was low. Moreover, the analysis was based on written answers only, without interviews, so it describes the products rather than the processes of students' creative thinking. Future studies should use several items per indicator, involve more classes and schools, report inter-rater agreement, and combine written tests with interviews.

## 5. Conclusion

The mathematical creative thinking ability of the eighth-grade students at Ashhabul Yamin Islamic Boarding School was predominantly at the moderately creative level: 38% of the students were moderately creative, 31% creative, 27% less creative, and 4% not creative, and none were highly creative. At the indicator level, originality was the strongest and fluency the weakest, with flexibility and elaboration in between. These results show that the students were generally able to solve problems correctly but rarely generated multiple ideas or solution methods. Mathematics instruction in this setting should therefore include regular open-ended and problem-posing tasks that explicitly require more than one solution. Future research should use instruments with several items per indicator, involve larger and more diverse samples of pesantren students, and combine written tests with interviews to examine students' creative thinking processes.

*Declaration of AI-Assisted Technologies*

During the preparation of this manuscript, the authors used AI-assisted tool for translating content from Indonesian into English and improving language clarity and grammar. The authors carefully reviewed and revised the AI-assisted output and take full responsibility for the content of the manuscript.

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