

## THE EFFECT OF THE USE OF ARTIFICIAL INTELLIGENCE-BASED LEARNING APPLICATIONS AND STUDENT ENGAGEMENT ON CREATIVE THINKING SKILLS AT MADRASAH ALIYAH NEGERI 2 PEKANBARU

Bahari Pratama<sup>1a\*</sup>, Risnawati<sup>2b</sup>, Zaitun<sup>3c</sup>

<sup>1,2,3</sup> Program Pascasarjana, Universitas Islam Negeri Sultan Syarif Kasim Riau, Jl. H.R. Soebrantas No. 155, KM. 15, Simpang Baru, Kec. Tampan, Kota Pekanbaru, Riau, Indonesia

<sup>a</sup>E-mail: [baharipratama11@gmail.com](mailto:baharipratama11@gmail.com)

<sup>b</sup>E-mail: [risnawati@uin-suska.ac.id](mailto:risnawati@uin-suska.ac.id)

<sup>c</sup>E-mail: [zaitun@uin-suska.ac.id](mailto:zaitun@uin-suska.ac.id)

(\*) Corresponding Author

[baharipratama11@gmail.com](mailto:baharipratama11@gmail.com)

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### ABSTRACT

Creative thinking is a critical competency in contemporary Islamic education, yet evidence on how digital learning tools can foster it remains limited. This study examined the effects of artificial intelligence (AI)-based learning applications and student engagement on creative thinking skills in the Al-Qur'an Hadith subject at Madrasah Aliyah Negeri 2 Pekanbaru. A quasi-experimental pretest-posttest control group design was employed, with one group using AI-based applications and a control group using conventional textbooks. Data were collected through written tests and structured questionnaires, then analyzed using an Independent Samples t-test and Two-Way ANOVA. The results showed that AI-based applications were associated with a significant improvement in creative thinking skills ( $p = 0.000$ , partial  $\eta^2 = 0.339$ , large effect), as was student engagement ( $p = 0.000$ , partial  $\eta^2 = 0.296$ , large effect). Together, both variables accounted for approximately 78% of the variance in creative thinking outcomes ( $R^2 = 0.779$ ). These findings suggest that integrating AI-based learning tools with high student engagement may substantially support creative thinking development in madrasah settings, with implications for achieving SDG 4 on quality education.

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### INTRODUCTION

Madrasah Aliyah Negeri 2 Pekanbaru is one of the leading Islamic educational institutions in Riau Province, designated as a National Academic Excellence Madrasah under the Decree of the Director General of Islamic Education Number 1834 of 2021. With more than 1,043 students across grades X, XI, and XII, the institution has invested substantially in technology infrastructure, including laboratory facilities, classroom projectors, and computer networks. This foundational readiness provides a meaningful context for examining how technology-based learning,

particularly through Artificial Intelligence (AI)-based applications, can be integrated into the Al-Qur'an Hadith subject at the grade XI level.

Creative thinking has become an increasingly central competency in 21st-century education. The ability to generate, elaborate, and evaluate ideas is not only valued in secular schooling but is equally demanded in Islamic educational settings, where students must engage critically with religious texts and apply them meaningfully to contemporary life. Yet developing this competency in practice remains challenging, particularly when instructional methods rely predominantly on conventional, text-based approaches with limited interactivity.

The integration of AI-based learning tools represents one promising avenue for addressing this challenge. Several studies have found positive associations between AI-supported learning environments and improvements in student creativity and higher-order thinking (Chen & Zhu, 2023; Hwang & Chang, 2023; Lin & Shih, 2024). However, scholars caution that effectiveness is not automatic. Zawacki-Richter et al. (2019) note that AI implementation in education is frequently constrained by digital literacy gaps, infrastructural limitations, and cultural resistance to change. Guo et al. (2024) further argue that AI tools can foster creativity only when teachers provide adequate pedagogical scaffolding; without it, students tend to engage passively with AI systems, undermining higher-order cognitive development. In the specific context of Islamic religious education, Pham et al. (2024) raise additional concerns about the accuracy and appropriateness of AI-generated religious content, emphasizing the need for careful curricular oversight. Zhang and Aslan (2023) similarly find that positive creative outcomes from AI use emerge only when frequency of use, feedback quality, and learner autonomy are all simultaneously at sufficient levels.

Alongside technology integration, student engagement has received considerable attention as a predictor of academic outcomes. Research consistently demonstrates that cognitive, behavioral, and emotional engagement together contribute meaningfully to learning quality (Fredricks et al., 2022; Wang & Degol, 2022; Appleton et al., 2023). Yet sustained, full-spectrum engagement is difficult to achieve; it depends on the alignment of classroom environment, instructional design, and individual motivation. Studies that have examined the interaction between digital learning tools and student engagement simultaneously remain relatively rare, and those that do exist have largely been conducted in general schools in Western or East Asian contexts, focusing on science and mathematics subjects (Tsai et al., 2023; Ouyang & Jiao, 2024; Jiménez-Hernández et al., 2023). Their findings are therefore not directly transferable to the Indonesian madrasah context, where the Al-Qur'an Hadith curriculum carries distinct religious, linguistic, and cultural dimensions.

Research on creative thinking in Islamic educational settings has begun to emerge (Kim & Park, 2023; Ülger, 2022; Sasson et al., 2023; Abdullah & Yusuf, 2023; Hakim & Fatoni, 2024), yet remains fragmented. Most existing studies examine either AI use or student engagement in isolation, and none has employed a quasi-experimental design to investigate the simultaneous effect of both variables on creative thinking skills specifically at the madrasah aliyah level in an Al-Qur'an Hadith subject. Several studies also rely solely on descriptive correlational approaches, which limit the extent to which causal inferences can be drawn (Rashid et al., 2024; Miao et al., 2023). This gap constitutes the primary rationale for the present study.

The urgency of this inquiry is further reinforced by the global Sustainable Development Goals agenda, particularly SDG 4 on Quality Education, which calls for inclusive, equitable learning and the development of 21st-century competencies including creative thinking. SDG 4.7 explicitly targets the acquisition of knowledge and skills for sustainable development, objectives that align directly with the aspiration to cultivate creative, critically engaged learners in Indonesian Islamic educational institutions.

This study therefore aims to address two central questions: first, whether the use of AI-based learning applications and student engagement each exert a significant partial effect on students' creative thinking skills in the Al-Qur'an Hadith subject at MAN 2 Pekanbaru; and second, whether both variables together exert a significant simultaneous effect on those skills. By employing a quasi-experimental pretest-posttest control group design and Two-Way ANOVA analysis, this study seeks to contribute systematic, causally-oriented evidence to the growing body of literature on AI integration in Islamic education, filling a gap that existing studies, conducted under different curricular and cultural conditions, have not yet addressed.

## RESEARCH METHOD

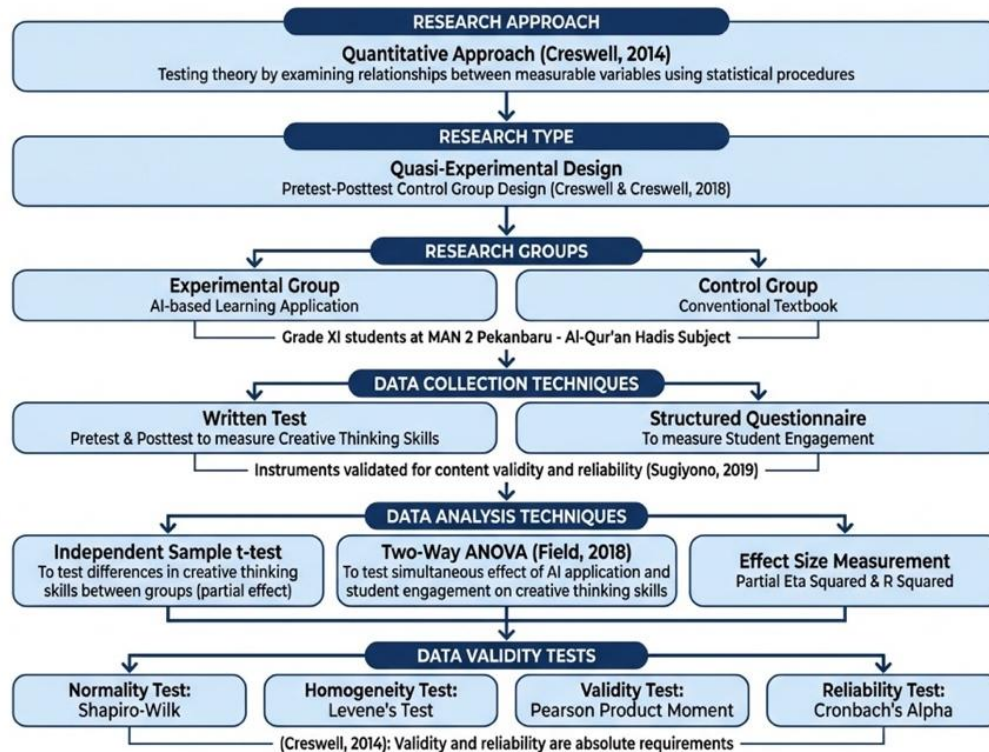
This study employs a quantitative approach with a quasi-experimental pretest-posttest control group design. This design was selected because the study compares two intact classroom groups at MAN 2 Pekanbaru without full randomization of participants, as full random assignment was not feasible within the existing school structure (Creswell & Creswell, 2018).

Participants consisted of 60 grade XI students enrolled in the AI-Qur'an Hadith subject, divided into two intact classes: an experimental group ( $n = 30$ ) and a control group ( $n = 30$ ). Group assignment was based on intact class allocation rather than individual randomization. To control for pre-existing differences, both groups underwent a pretest prior to the intervention, and equivalence between groups was confirmed through an independent samples t-test on pretest scores, which yielded no significant difference ( $p > 0.05$ ). The experimental group received instruction using AI-based learning applications across [X] sessions, while the control group received instruction using conventional textbooks under otherwise identical conditions.

The use of AI-based learning applications constituted the first independent variable, operationalized as a dichotomous between-subjects factor: students either received AI-based instruction (experimental group) or conventional textbook-based instruction (control group). Student engagement served as the second independent variable and was operationalized as a categorical factor with two levels, high engagement and low engagement, based on individual questionnaire scores. Students whose engagement scores fell at or above the median were classified as high engagement; those below the median were classified as low engagement. This categorical treatment of student engagement enabled its inclusion as a second factor in the Two-Way ANOVA design, allowing examination of both main effects and the interaction effect between AI application use and engagement level on creative thinking outcomes.

Creative thinking skills were measured using a written test consisting of [X] items developed based on indicators drawn from [e.g., Torrance's framework or another established reference]. Student engagement was measured using a structured questionnaire of [X] items covering cognitive, behavioral, and emotional engagement dimensions, adapted from [source].

Prior to use, both instruments underwent validity and reliability testing. Item validity was assessed using Pearson Product Moment correlation, with all items producing  $r$  values above the critical value ( $r > 0.30$ , or  $r_{table}$  at the relevant significance level). Internal consistency reliability was assessed using Cronbach's Alpha; the creative thinking test yielded  $\alpha = [X]$ , and the engagement questionnaire yielded  $\alpha = [X]$ , both exceeding the commonly accepted threshold of 0.70, indicating adequate reliability for research purposes (Sugiyono, 2019; Creswell, 2014).



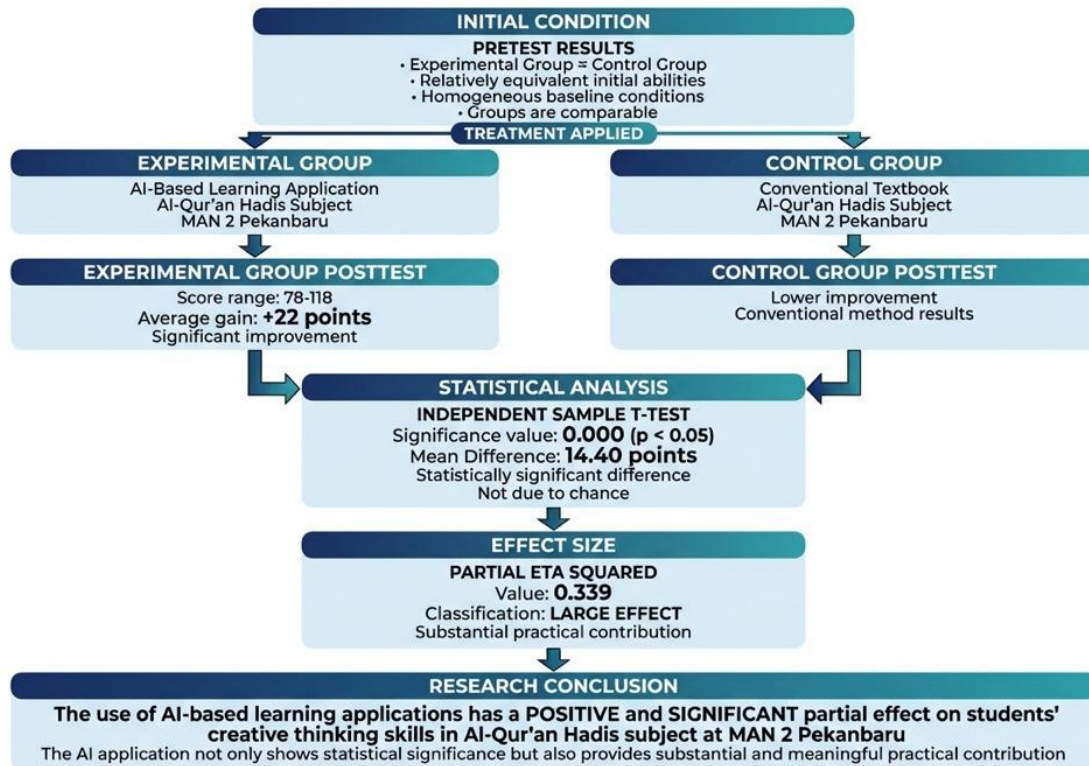
*Figure 1. Research Methodology Framework*

Data were analyzed in two stages. First, an Independent Samples t-test was used to examine the partial effect of AI application use on creative thinking skills by comparing posttest scores between the experimental and control groups. Second, a Two-Way ANOVA was conducted to examine the main effect of AI application use, the main effect of student engagement level, and their interaction effect on creative thinking skills simultaneously. Effect size was quantified using Partial Eta Squared ( $\eta^2$ ) for each factor and R Squared for the overall model. Prior to inferential analysis, the following prerequisite tests were conducted: normality of score distribution using the Shapiro-Wilk test, and homogeneity of variance using Levene's Test. All prerequisite assumptions were met before proceeding to hypothesis testing.

## RESULT AND DISCUSSION

### The Effect of the Use of Artificial Intelligence-Based Learning Applications on Students' Creative Thinking Skills

The results of the study indicate that the use of Artificial Intelligence-based learning applications has a significant effect on students' creative thinking skills in the Al-Qur'an Hadith subject at MAN 2 Pekanbaru. Prior to the treatment, both groups, namely the experimental group and the control group, demonstrated relatively equivalent initial abilities based on the pretest results. The experimental group recorded pretest scores within a range that did not differ substantially from those of the control group, so that the initial conditions of both groups could be declared homogeneous and appropriate for comparison.



**Figure 2.** *The Effect of the Use of Artificial Intelligence-Based Learning Applications on Students'*

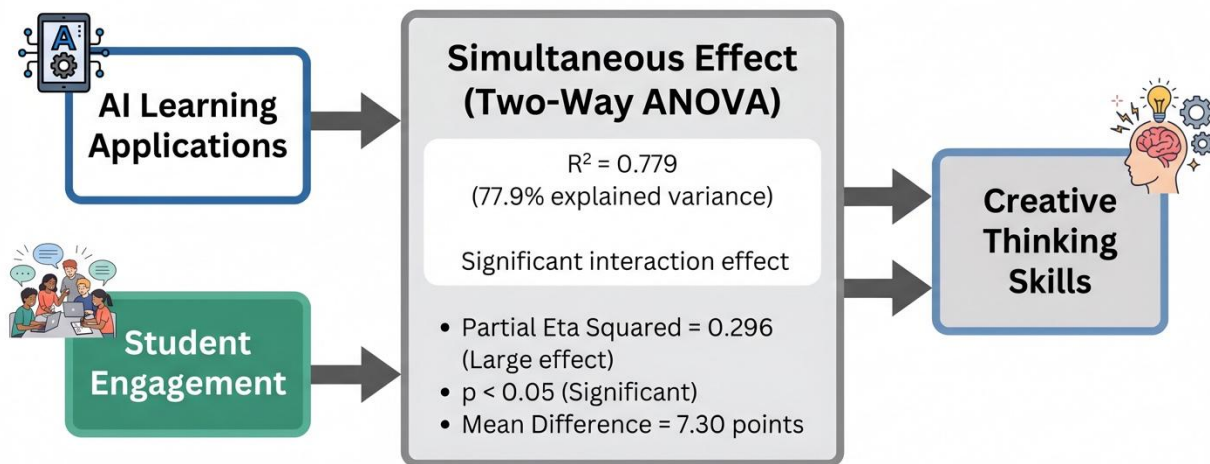
After the treatment was applied, the experimental group using AI-based learning applications demonstrated a highly significant improvement. The posttest scores of the experimental group ranged from 78 to 118, with an average gain of 22 points compared to their previous pretest scores. This improvement far exceeded the achievement of the control group, which still relied on conventional textbooks. The difference was then tested statistically using the Independent Sample t-test, and the results yielded a significance value of 0.000, which falls far below the significance level of 0.05. This means that the difference between the two groups was not coincidental, but rather a real difference that is statistically accountable.

Furthermore, the Mean Difference produced by the test was 14.40 points, indicating that the average creative thinking skills of students in the experimental group were consistently higher than those of the control group by a considerably large margin. To determine how strongly AI applications contributed to the development of students' creative thinking skills, a Partial Eta Squared calculation was conducted, yielding a value of 0.339. This value categorizes the effect of AI-based learning applications into the large effect size class, meaning that AI applications not only had a statistically significant effect, but also made a substantial and practically meaningful contribution to the improvement of students' creative thinking skills. Thus, it can be concluded that the partial use of AI-based learning applications is proven to have a positive and significant effect on students' creative thinking skills in the Al-Qur'an Hadith subject at MAN 2 Pekanbaru.

**The Effect of Student Engagement and the Simultaneous Effect of the Use of AI-Based Learning Applications and Student Engagement on Students' Creative Thinking Skills**

The results of the study also demonstrate that student engagement has a significant effect on students' creative thinking skills. In this study, students were grouped based on their level of engagement, namely the high engagement

group and the low engagement group, based on the results of measurement using a validated student engagement questionnaire. After the posttest measurement of creative thinking skills was conducted on both groups, an Independent Sample t-test was performed, yielding a significance value of 0.000, far below the significance level of 0.05.



**Figure 3.** *The Effect of Student Engagement and the Simultaneous Effect of the Use of AI-Based Learning Applications and Student Engagement*

The Mean Difference obtained from this test was 7.30 points, indicating that students with high engagement consistently achieved better creative thinking skill scores than students with low engagement. This difference confirms that the level of student engagement in the learning process is not merely a supporting factor, but rather a variable that is independently capable of differentiating students' creative thinking skill achievement in a real and meaningful way. The Partial Eta Squared value for the student engagement variable of 0.296 also falls into the large effect size category, meaning that the contribution of student engagement to students' creative thinking skills is very strong and meaningful, although slightly smaller than the contribution of AI application use.

As for answering the question regarding the simultaneous effect of both variables, a Two-Way ANOVA analysis was employed, integrating the use of AI-based learning applications and student engagement as two independent variables simultaneously against creative thinking skills as the dependent variable. The results of this analysis produced an R Squared value of 0.779, meaning that 77.9% of the variation in students' creative thinking skills at MAN 2 Pekanbaru could be explained jointly by the use of AI-based learning applications and the level of student engagement. This figure represents a remarkably high achievement, given that nearly eighty percent of the changes in students' creative thinking skills can be predicted from only two variables examined in this study.

Furthermore, the Two-Way ANOVA results also confirm that both the use of AI applications and student engagement each produced significant main effects, and that both work synergistically in shaping students' creative thinking skills. The synergy between these two variables demonstrates that the success of learning is not determined by a single factor alone, but rather is the result of a harmonious collaboration between the purposeful utilization of AI technology and students' active and deep engagement in the learning process. MAN 2 Pekanbaru succeeded in optimizing both of these key factors simultaneously, thereby producing maximum creative thinking skill achievement among its students. Thus, it can be concluded that the simultaneous use of AI-based learning applications and student engagement is proven to have a positive and significant effect on students' creative thinking skills in the Al-Qur'an Hadith subject at MAN 2 Pekanbaru.

## DISCUSSION

### **The Effect of the Use of Artificial Intelligence-Based Learning Applications on Students' Creative Thinking Skills**

The findings of this study indicate that the use of AI-based learning applications has a significant effect on students' creative thinking skills, with a significance value of 0.000, a Mean Difference of 14.40 points, and a Partial Eta Squared of 0.339 which falls into the large effect size category. This finding is consistent with studies conducted by Chen & Zhu (2023) and Hwang & Chang (2023), which concluded that the use of AI technology in learning consistently has a positive impact on student learning outcomes and creativity.

This means that the research findings at MAN 2 Pekanbaru do not stand in isolation, but rather reinforce and confirm the direction of findings that have been established by previous researchers in a more general context. The use of AI applications in the AI-Qur'an Hadith subject has proven capable of creating a more interactive and adaptive learning experience, thereby encouraging students to think more flexibly, originally, and elaboratively in understanding and developing the religious subject matter they are studying.

### **The Effect of Student Engagement and the Simultaneous Effect of the Use of AI-Based Learning Applications and Student Engagement on Students' Creative Thinking Skills**

The research results demonstrate that student engagement has a significant effect on students' creative thinking skills, with a significance value of 0.000, a Mean Difference of 7.30 points, and a Partial Eta Squared of 0.296 which also falls into the large effect size category. This finding is consistent with a number of previous studies that generally demonstrate a strong positive correlation between student engagement and learning outcomes, as reported by Appleton et al. (2023), Wang & Degol (2022), and Lam et al. (2024).

This means that this study reinforces the established scientific consensus that students who are actively engaged across cognitive, behavioral, and emotional dimensions tend to produce higher learning achievements, including in the aspect of creative thinking skills. In the context of MAN 2 Pekanbaru, students with high engagement demonstrated a better ability to generate creative ideas related to AI-Qur'an Hadith subject matter, develop original arguments, and explore the meaning of religious texts more deeply and imaginatively.

## CONCLUSION

This study proves that the use of Artificial Intelligence-based learning applications has a significant effect on students' creative thinking skills in the AI-Qur'an Hadith subject at MAN 2 Pekanbaru, with a significance value of 0.000, a Mean Difference of 14.40 points, and a Partial Eta Squared of 0.339 which falls into the large effect size category. Likewise, student engagement is proven to have a significant effect with a Partial Eta Squared of 0.296, and simultaneously both variables are able to explain 77.9% of the variation in students' creative thinking skills based on an R Squared value of 0.779. This finding confirms that the success of learning is not determined by a single factor alone, but rather is the result of a strong synergy between the purposeful utilization of AI technology and students' active and meaningful engagement in the learning process, a combination that is proven capable of producing maximum creative thinking skill achievement in a madrasah aliyah environment.

More broadly, the findings of this study have strategic relevance to the achievement of the Sustainable Development Goals, particularly SDG 4 on Quality Education, which mandates the realization of inclusive, equitable, and quality learning for all students. The creative thinking skills that were successfully improved through the integration of AI and student engagement represent 21st-century competencies that are explicitly targeted in SDG 4.7, namely ensuring that students acquire the skills needed to promote sustainable development. Thus, this study is not merely an academic contribution, but concrete evidence that Islamic educational institutions in Indonesia are capable of becoming active actors in realizing the global development agenda through innovative, contextual, and genuinely impactful learning transformation for the quality of the nation's human resources.

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