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Integrating AI Chatbots into Islamic Education: Effects on Students' Self-Regulated and Learning Outcomes at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung

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Abstract

Research Objective – This study aims to examine the effects of integrating AI-powered chatbots into Islamic education on students' self-regulated learning (SRL) and learning outcomes at the junior high school level.

Methodology – A quantitative quasi-experimental design with a non-equivalent control group pretest–posttest was employed. The participants were 64 eighth-grade students at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung, Indonesia, divided into an experimental group receiving AI chatbot–supported instruction and a control group receiving conventional teacher-centered instruction. Data were collected using an adapted Self-Regulated Learning questionnaire and an achievement test, and analyzed through descriptive statistics, independent-samples t-tests, gain score analysis, and Pearson correlation.

Findings – The results indicate that students in the experimental group demonstrated significantly higher improvements in both self-regulated learning and learning outcomes compared to the control group ($p < 0.001$). A strong positive correlation was also found between SRL and learning outcomes ($r = 0.68$), suggesting that enhanced self-regulation contributes meaningfully to academic achievement.

Research Implications/Limitations – The findings highlight the pedagogical potential of AI chatbots to foster learner autonomy and academic performance in Islamic education, although generalizability is limited by the single-institution sample.

Originality/Value – This study provides novel empirical evidence on AI chatbot integration in Islamic secondary education, linking SRL development with learning outcomes within a faith-based context.

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INTRODUCTION

Islamic education at the secondary level, particularly in junior high school settings, plays a strategic role in shaping students' cognitive, affective, and moral development. SMP (Junior High School) is expected not only to transmit Islamic knowledge but also to cultivate independent learners who are capable of regulating their own learning processes in increasingly complex digital environments. However, empirical evidence shows that the implementation of Islamic education in many Junior High School still faces persistent pedagogical challenges, including teacher-centered instruction, limited use of adaptive learning technologies, and students' low autonomy in managing their learning activities.[1, 2] These challenges have implications for students' learning outcomes and their ability to develop self-regulated learning (SRL) skills, which are essential for lifelong learning in the digital age.[3]

Self-regulated learning has been widely recognized as a key determinant of academic success, encompassing learners' abilities to plan, monitor, and evaluate their learning strategies.[4] Meta-analytical and systematic review studies consistently demonstrate that students with strong SRL skills achieve higher academic performance, stronger motivation, and better learning persistence.[5] In the context of digital learning, SRL becomes even more critical, as learners are required to navigate abundant information, manage distractions, and take responsibility for their own progress.[6] Despite its importance, studies indicate that many students in religious and traditional educational institutions still struggle to develop effective SRL strategies, particularly when digital technologies are introduced without adequate pedagogical scaffolding.[7]

Recent advances in artificial intelligence (AI) have opened new opportunities for addressing these challenges. AI-driven technologies—such as learning analytics, adaptive systems, and intelligent tutoring tools—have demonstrated considerable potential to personalize learning, enhance engagement, and support learners' self-regulation.[8] Among these technologies, AI-powered educational chatbots have gained increasing attention due to their

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[1] M. Ridlwan and Asrori Asrori, "Problems of Implementation of Islamic Religious Education at Muhammadiyah Junior High School 4 Gadung Surabaya," in *International Conference on Islamic and Muhammadiyah Studies (ICIMS 2022)* (Amsterdam: Atlantis Press, 2022), 312–318, https://doi.org/10.2991/assehr.k.220708.039

[2] Asrori, Asrori. *Inovasi Belajar dan Pembelajaran PAI (Teori dan Aplikatif)*. Surabaya: UMSurabaya Press, 2019. http://repository.um-surabaya.ac.id/id/eprint/4629.

[3] Ahmad Faza and Ilyana Agri Lestari, "Self-Regulated Learning in the Digital Age," *The International Review of Research in Open and Distributed Learning* 26, no. 2 (2025): 23–58, https://doi.org/10.19173/irrodl.v26i2.8119

[4] Asrori, Asrori. *Psikologi Pendidikan: Pendekatan Multidisipliner*. Banyumas: Pena Persada, 2020. https://repository.um-surabaya.ac.id/id/eprint/4461

[5] Maria Theobald, "Self-Regulated Learning Training Programs," *Contemporary Educational Psychology* 66 (2021), https://doi.org/10.1016/j.cedpsych.2021.101976

[6] Seban, Peter, and Kamila Urban. "Examining the Utilisation of Learning Techniques and Strategies among Pedagogy Students: Implications for Self-Regulated Learning." *Journal of Pedagogy* 15, no. 1 (2024): 27–49. https://doi.org/10.2478/jped-2024-0002.

[7] Hafshah Safrindra F., A. Asrori, and R. Rusman, "Questions Students Have Method," *Risâlah* 9, no. 2 (2023): 552–564, https://doi.org/10.31943/jurnal_risalah.v9i2.478

[8] Srivastava, Khusboo. "Leveraging Artificial Intelligence for Sustainable and Inclusive Education: Opportunities, Challenges, and Recommendations." In *Transforming Business Education through Artificial Intelligence*. Boca Raton, FL: CRC Press, 2025. https://doi.org/10.1201/9781998511471-18.

ability to provide real-time feedback, personalized guidance, and continuous learning support. Systematic reviews indicate that educational chatbots can positively influence learning outcomes, motivation, and metacognitive regulation when integrated effectively into instructional designs.[9] Furthermore, chatbots are particularly suitable for supporting SRL, as they can prompt goal setting, remind learners of tasks, and facilitate reflective learning processes.[10]

In the broader educational context, empirical studies have confirmed that AI-supported learning environments can enhance student engagement and learning effectiveness, especially in distance and blended learning settings.[11] However, most of these studies are situated in higher education or general education contexts, with limited attention to faith-based or Islamic educational institutions. While several studies have explored innovative instructional models in Islamic education—such as cooperative learning, team-assisted individualization, and inquiry-based methods—to improve creativity and learning outcomes,[12] the integration of advanced AI technologies, particularly chatbots, remains underexplored. Existing research in Islamic education has largely focused on pedagogical strategies and curriculum integration of Islamic values with science and technology,[13] rather than on AI-driven instructional support systems.[14]

Moreover, current literature on AI chatbots in education tends to emphasize cognitive achievement or general engagement outcomes, often overlooking the specific mechanisms through which chatbots support students' self-regulated learning.[15] Although recent international studies demonstrate the effectiveness of AI chatbots in enhancing SRL among university students and EFL learners,[16] there is a notable lack of empirical evidence at the secondary school level, especially within Islamic schooling contexts such as SMP. Additionally, few studies simultaneously examine both SRL and learning outcomes as

[9] Elkot, Mohamed Ali, Abdalilah Alhalangy, Mohammed Abd Algane, and Rabea Ali. "Pedagogical Influence of AI-Chatbots on Learning Outcomes: A Systematic Review." *International Journal of Educational Methodology* 11, no. 4 (2025): 527–540. https://doi.org/10.12973/ijem.11.4.527

[10] Guan, Rui, Mladen Raković, Guanliang Chen, and Dragan Gašević. "How Educational Chatbots Support Self-Regulated Learning? A Systematic Review of the Literature." *Educational Information Technologies* 30 (2025): 4493–4518. https://doi.org/10.1007/s10639-024-12881-y.

[11] Babu, C. V. Suresh, M. Yuvansankar, and K. Tharuneshwaran, "Personalized Learning and Student Engagement: Leveraging AI for Enhanced Learning Experiences in Distance Education," in *AI and Learning Analytics in Distance Learning*, ed. Henrique S. Mamede and Arnaldo Santos (Hershey, PA: IGI Global Scientific Publishing, 2025), 73–102, https://doi.org/10.4018/979-8-3693-7195-4.ch004

[12] Abbas Lumbilsa, A. Asrori, and R. Rusman. "Improving Creativity and Learning Outcomes Through Team-Assisted Individualization Learning Islamic Education Lessons." *EDUKASI: Jurnal Pendidikan Islam* 11, no. 2 (2023): 199–213. https://doi.org/10.54956/edukasi.v11i2.371.

[13] Asrori, Asrori, and Rusman Rusman. *Filsafat Pendidikan Islam: Sebuah Pendekatan Filsafat Islam Klasik*. Malang: Pustaka Learning Center, 2020. http://repository.um-surabaya.ac.id/4460/

[14] Hidayat, Moch. Charis, Sokhibul Arifin, Asrori Asrori, and Rusman. "Integration Science Technology with Islamic Values: Empowering Education Model." In *Proceedings of the International Conference*, Atlantis Press, 2020. https://doi.org/10.2991/assehr.k.200529.202.

[15] Suardi. "The Role of Real-Time Learning Analytics and Pedagogical Chatbots in Improving Digital Literacy and Self-Regulated Learning Among Islamic Senior High School Students." *Asian Journal of Applied Education (AJAE)* 4, no. 4 (2025): 473–486. https://doi.org/10.55927/ajae.v4i4.15369.

[16] Li, Xiaoqing, Yifan Zhang, and Hui Wang. "Enhancing Chinese EFL University Students' Self-Regulated Learning through AI Chatbot Intervention." *Learning and Motivation* 87 (2025). https://doi.org/10.1016/j.lmot.2025.102191

interconnected variables, despite theoretical perspectives suggesting that improvements in SRL should directly contribute to enhanced academic achievement.[17]

This gap becomes more pronounced when considering the contextual realities of Indonesian junior high school. Studies reveal that the adoption of digital technologies in Islamic schools is often constrained by limited infrastructure, pedagogical readiness, and concerns regarding ethical and value alignment.[18] While recent scholarship has addressed ethical considerations and trust in digital and AI-based systems within educational organizations,[19] empirical investigations that operationalize these technologies in real classroom settings remain scarce. In particular, there is minimal research examining how AI chatbots can be pedagogically aligned with Islamic values while simultaneously fostering students' autonomy and learning effectiveness.

Based on this critical gap, this study seeks to investigate the integration of AI chatbots into Islamic education at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung, focusing on their effects on students' self-regulated learning and learning outcomes. The novelty of this study lies in three key aspects. First, it extends existing AI-in-education research by situating AI chatbot implementation within an Islamic secondary education context, an area that remains underrepresented in the literature. Second, it empirically examines the dual impact of AI chatbots on both self-regulated learning and learning outcomes, offering a more comprehensive understanding of their pedagogical effectiveness. Third, this study provides context-specific evidence from SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung, contributing practical insights into how AI technologies can be integrated ethically and pedagogically within junior high school education systems.

By addressing these gaps, this research is expected to contribute theoretically to the discourse on AI-supported self-regulated learning and practically to the development of innovative, value-based instructional models for Islamic education in the digital era.

METHOD

This study adopted a quantitative research approach employing a quasi-experimental design, specifically a non-equivalent control group pretest–posttest design, to investigate the effects of integrating AI-powered chatbots into Islamic education on students' self-regulated learning (SRL) and learning outcomes. This design was selected because the research was conducted in an authentic classroom setting where random assignment of participants was not

[17] Theobald, Maria. "Self-Regulated Learning Training Programs Enhance University Students' Academic Performance, Self-Regulated Learning Strategies, and Motivation: A Meta-Analysis." *Contemporary Educational Psychology* 66 (2021). https://doi.org/10.1016/j.cedpsych.2021.101976

[18] Huda, Miftachul, Asrori Asrori, Moch Charis Hidayat, Naili Saida, Murwanti Murwanti, Mukayat Al Amin, Hadi Kusnanto, and Syawal Syawal. "Digital Technology System Adaptation and Adoption: Insights into Administrative Management Framework System." In *Research Perspectives on Software Engineering and Systems Design*, edited by R. Silhavy and P. Silhavy, Lecture Notes in Networks and Systems 1492, 1–15. Cham: Springer, 2025. https://doi.org/10.1007/978-3-031-96775-7_28.

[19] Huda, Miftachul, Asrori Asrori, Shoffa Shoffan, Muhammad Ridlwan, Wijayadi Wijayadi, Sunyoto Hadi Prajitno, Ayu Lidya Paramita, and Waode Hamsia. "Ethics for Information and Communication Technology: Critical Insights into Building Social Harmony." In *Research Perspectives on Software Engineering and Systems Design*, edited by R. Silhavy and P. Silhavy, Lecture Notes in Networks and Systems 1492, 1–14. Cham: Springer, 2025. https://doi.org/10.1007/978-3-031-96775-7_27.

feasible, yet the design still allows for a systematic comparison between treatment and control groups and supports reasonable causal inference in educational research contexts.[20]

The research was carried out at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung, Indonesia, during the second semester of the academic year. The participants consisted of 64 eighth-grade students drawn from two intact classes. One class, comprising 32 students, was designated as the experimental group, while the other class, also consisting of 32 students, served as the control group. The selection of participants was conducted using purposive sampling, with careful consideration given to students' comparable academic abilities, age range, and prior exposure to digital learning environments, in order to reduce potential selection bias and ensure baseline equivalence between groups.[21]

Prior to the instructional intervention, both groups completed a pretest designed to measure their initial levels of self-regulated learning and academic achievement in Islamic education. The experimental intervention was implemented over eight instructional sessions, during which AI chatbot technology was integrated into the learning process as a supportive instructional tool. In the experimental group, the AI chatbot functioned as an interactive learning assistant that provided on-demand explanations of learning materials, personalized responses to students' inquiries, formative feedback, reminders for learning tasks, and reflective prompts aimed at fostering goal setting, self-monitoring, and self-evaluation processes. These features were deliberately designed to align with the core components of self-regulated learning theory and to ensure that the chatbot interactions remained consistent with Islamic values and the junior high school curriculum. Meanwhile, the control group received conventional instruction based on teacher-centered methods, including lectures, guided discussions, and textbook-based assignments, which represent the prevailing instructional practices in many Islamic secondary schools.

Data on self-regulated learning were collected using an adapted version of the Motivated Strategies for Learning Questionnaire (MSLQ), originally developed by Pintrich and colleagues.[22] The instrument was contextualized to reflect Islamic education content and digital learning conditions, focusing on key SRL dimensions such as learning planning, monitoring, and evaluation. Students' learning outcomes were measured using a teacher-developed achievement test administered as both pretest and posttest, which assessed students' cognitive mastery of the instructional content. The content validity of the test was established through expert judgment involving Islamic education specialists, while internal consistency reliability was examined using Cronbach's alpha coefficient, following standard procedures in educational measurement.[23]

The collected data were analyzed using inferential statistical techniques. Prior to hypothesis testing, assumption tests for normality and homogeneity of variance were

[20] John W. Creswell and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th ed. (Thousand Oaks, CA: SAGE Publications, 2018), 158–182.
[21] William R. Shadish, Thomas D. Cook, and Donald T. Campbell, *Experimental and Quasi-Experimental Designs for Generalized Causal Inference* (Boston: Houghton Mifflin, 2002), 103–134.
[22] Jack R. Fraenkel, Norman E. Wallen, and Helen H. Hyun, *How to Design and Evaluate Research in Education*, 10th ed. (New York: McGraw-Hill Education, 2019), 261–289.
[23] Paul R. Pintrich et al., *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)* (Ann Arbor: University of Michigan, 1991), 43–47.

conducted. Depending on the distribution of the data, independent samples t-tests or appropriate non-parametric alternatives were employed to examine differences in self-regulated learning and learning outcomes between the experimental and control groups. In addition, gain score analysis was used to evaluate the magnitude of improvement resulting from the AI chatbot intervention, and correlational analysis was conducted to explore the relationship between students' self-regulated learning and their academic achievement. These analytical procedures are consistent with established practices in research on technology-enhanced and AI-supported learning environments.[24]

Ethical considerations were rigorously observed throughout the research process. Approval was obtained from the junior high school authorities prior to data collection, and informed consent was secured from all participants. Students' anonymity and the confidentiality of research data were maintained, and all data were used exclusively for academic and research purposes.

RESULTS AND DISCUSSION

Results

This section presents the empirical findings of the study concerning the effects of integrating AI-powered chatbots into Islamic education on students' self-regulated learning (SRL) and learning outcomes at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung. The results are organized into four subsections: (1) descriptive statistics of SRL and learning outcomes, (2) assumption testing, (3) comparative analysis between experimental and control groups, and (4) the relationship between SRL and learning outcomes.

Descriptive Statistics of Self-Regulated Learning

Descriptive statistical analysis was conducted to provide a comprehensive overview of students' self-regulated learning (SRL) levels before and after the implementation of the instructional intervention integrating AI chatbots. This analysis was intended to demonstrate both the initial equivalence between the experimental and control groups and the extent of change following the intervention.

Table 1. Descriptive Statistics of Self-Regulated Learning Scores

Group	Test Phase	Mean (M)	Standard Deviation (SD)	Gain Score
Experimental Group	Pretest	68.47	7.82	
	Posttest	82.63	6.94	14.16
Control Group	Pretest	67.91	8.05	
	Posttest	72.18	7.56	4.27

As summarized in Table 1, prior to the treatment, the experimental and control groups exhibited relatively comparable levels of self-regulated learning. The experimental group recorded a mean SRL score of 68.47 (SD = 7.82), while the control group achieved a mean score of 67.91 (SD = 8.05). The similarity in mean values and standard deviations

[24] Barry J. Zimmerman, "Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects," *American Educational Research Journal* 45, no. 1 (March 2008): 166–183, https://doi.org/10.3102/0002831207312909

indicates that students in both groups began the study with nearly equivalent SRL capacities. This baseline comparability is crucial, as it suggests that any differences observed at the posttest stage are more likely attributable to the instructional intervention rather than to pre-existing disparities in self-regulation skills.

Following the instructional intervention, a clear divergence emerged between the two groups, as shown in Table 1. The experimental group, which participated in AI chatbot–supported learning activities, demonstrated a substantial increase in SRL, with a posttest mean score rising to 82.63 (SD = 6.94). This improvement reflects a marked enhancement in students' ability to plan learning strategies, monitor their understanding, regulate learning resources, and evaluate their learning outcomes. In contrast, the control group, which received conventional instruction without AI chatbot integration, showed a more modest improvement, attaining a posttest mean score of 72.18 (SD = 7.56).

The magnitude of improvement becomes more apparent when examining the gain scores presented in Table 1. The experimental group achieved a mean gain of 14.16 points, which is substantially higher than the gain observed in the control group (M_gain = 4.27). This difference indicates that the integration of AI chatbots contributed meaningfully to the development of students' self-regulated learning, beyond what could be achieved through traditional instructional approaches alone.

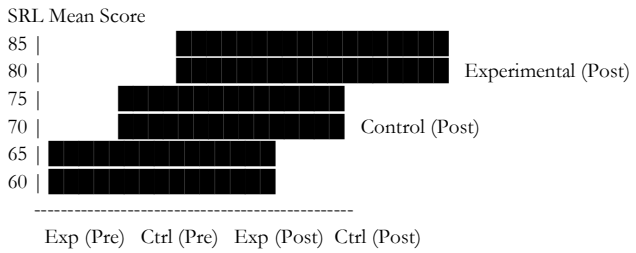

Figure 1. Comparison of Pretest–Posttest SRL Mean Scores

To further clarify these patterns, figure 1 visually compares the pretest and posttest SRL mean scores of both groups. The figure illustrates that while both groups experienced an increase in SRL scores over time, the experimental group exhibited a markedly steeper upward trend. This visual representation reinforces the numerical findings in Table 1, highlighting the stronger impact of AI chatbot–assisted instruction on students' self-regulated learning development.

Overall, the combined evidence from table 1 and figure 1 suggests that AI chatbot–assisted instruction creates a learning environment that actively encourages students to take greater responsibility for their learning processes. The availability of structured feedback, immediate assistance, and interactive dialogue appears to function as cognitive and metacognitive scaffolding, enabling students to develop more robust self-regulatory behaviors compared to those engaged in conventional learning settings.

Descriptive Statistics of Learning Outcomes

Descriptive statistical analysis was conducted to examine students' learning outcomes before and after the implementation of the instructional intervention integrating AI chatbots. This analysis aimed to identify baseline equivalence between the experimental and control groups and to describe the extent of academic improvement following the intervention.

Table 2. Descriptive Statistics of Learning Outcomes Scores

Group	Test Phase	Mean (M)	Standard Deviation (SD)	Gain Score
Experimental Group	Pretest	69.22	8.11	
	Posttest	84.06	7.02	14.84
Control Group	Pretest	68.75	7.96	
	Posttest	74.31	7.48	5.56

As presented in table 2, the pretest results revealed no substantial difference in learning outcomes between the two groups. The experimental group obtained a mean pretest score of 69.22 (SD = 8.11), while the control group recorded a mean score of 68.75 (SD = 7.96). The similarity in mean scores and standard deviations indicates that both groups began the study with comparable levels of academic achievement. This initial equivalence strengthens the internal validity of the study by ensuring that post-intervention differences are less likely to be influenced by pre-existing academic disparities.

Following the instructional intervention, a clear distinction emerged between the experimental and control groups. Students in the experimental group, who participated in AI chatbot–supported learning activities, demonstrated a substantial improvement in learning outcomes, achieving a posttest mean score of 84.06 (SD = 7.02). This increase suggests that the integration of AI chatbots facilitated deeper understanding of learning materials, improved engagement, and more effective knowledge construction. In contrast, the control group, which experienced conventional teacher-centered instruction, showed a more moderate improvement, with a posttest mean score of 74.31 (SD = 7.48).

The difference in academic progress between the two groups becomes more evident through gain score analysis, as summarized in table 2. The experimental group achieved a mean gain score of 14.84 points, which was substantially higher than the gain score of the control group (M_gain = 5.56). This finding indicates that AI chatbot–assisted instruction not only supported students in achieving higher posttest scores but also contributed meaningfully to the magnitude of learning improvement over the instructional period.

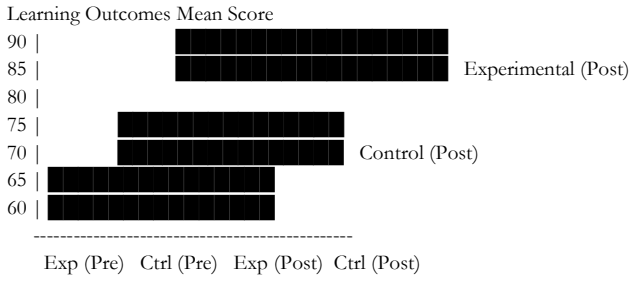

Figure 2. Comparison of Pretest–Posttest Learning Outcomes Mean Scores

To visually reinforce these findings, figure 2 illustrates the comparison of pretest and posttest mean scores for both groups. The figure shows that while learning outcomes improved in both groups, the experimental group exhibited a markedly steeper increase from pretest to posttest. This visual pattern corroborates the numerical evidence presented in Table 2, highlighting the stronger instructional impact of AI chatbot integration compared to conventional teaching approaches.

The descriptive findings suggest that AI chatbot–supported instruction provides an effective pedagogical environment that enhances students' academic achievement. By offering immediate feedback, personalized explanations, and continuous learning support, AI chatbots appear to function as instructional scaffolds that promote more meaningful learning and improved learning outcomes relative to traditional teacher-centered instruction.

Assumption Testing

Prior to conducting inferential statistical analyses, assumption testing was undertaken to ensure that the data met the fundamental requirements for the application of parametric statistical procedures. This step is essential in quantitative educational research, as violations of statistical assumptions may compromise the validity, reliability, and interpretability of inferential findings.

Table 3. Summary of Assumption Testing Results

Variable	Assumption Tested	Statistical Test	Sig. (p-value)	Decision
Self-Regulated Learning (SRL)	Normality	Kolmogorov–Smirnov Test	> 0.05	Normally Distributed
Learning Outcomes	Normality	Kolmogorov–Smirnov Test	> 0.05	Normally Distributed
Self-Regulated Learning (SRL)	Homogeneity	Levene's Test	> 0.05	Homogeneous Variance
Learning Outcomes	Homogeneity	Levene's Test	> 0.05	Homogeneous Variance

The assumption of normality was first examined using the Kolmogorov–Smirnov test for both self-regulated learning (SRL) and learning outcomes data. As presented in table 3, the results indicate that the significance values for all variables across both the experimental and control groups exceeded the conventional threshold of 0.05 ($p > 0.05$). These findings suggest that the distributions of SRL and learning outcomes scores did not significantly deviate from a normal distribution. Accordingly, the normality assumption—a key prerequisite for parametric statistical analysis—was satisfied for all variables under investigation.

In addition to normality, the assumption of homogeneity of variance was assessed using Levene's test. The results, also summarized in table 3, reveal no statistically significant differences in variance between the experimental and control groups for either SRL or learning outcomes ($p > 0.05$). This indicates that score variability across groups was relatively equivalent, thereby fulfilling the homogeneity of variance assumption required for group comparison using parametric tests.

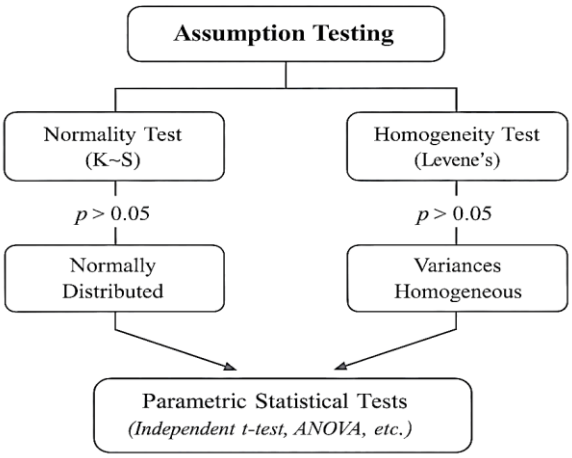

Figure 3. Conceptual Diagram of Assumption Testing Results

The combined results of the Kolmogorov–Smirnov and Levene's tests provide a strong statistical foundation for subsequent inferential analyses. As conceptually illustrated in figure 3, the confirmation of both data normality and variance homogeneity supports the methodological decision to employ parametric statistical techniques. Consequently, parametric tests—such as independent-samples t-tests and further comparative analyses—were deemed appropriate for examining the effects of AI chatbot–supported instruction on students' self-regulated learning and learning outcomes.

Comparative Analysis Between Experimental and Control Groups

To examine the effectiveness of AI chatbot–supported instruction, an independent-samples t-test was conducted to compare posttest scores between the experimental and control groups. This analysis aimed to determine whether the observed differences in self-regulated learning (SRL) and learning outcomes were statistically significant following the instructional intervention.

Table 4. Independent-Samples *t*-Test Results for Posttest Scores

Variable	Group	Mean (M)	Standard Deviation (SD)	*t*	df	*p*
Self-Regulated Learning (SRL)	Experimental	82.63	6.94	5.87	62	< 0.001
	Control	72.18	7.56			
Learning Outcomes	Experimental	84.06	7.02	5.14	62	< 0.001
	Control	74.31	7.48			

The results of the independent-samples t-test revealed a statistically significant difference in students' self-regulated learning scores between the two groups. As presented in table 4, the experimental group achieved a significantly higher posttest SRL score compared to the control group, with the analysis yielding $t(62) = 5.87$ and $p < 0.001$. This finding

indicates that students who engaged in AI chatbot–supported learning developed stronger self-regulatory skills than those who participated in conventional learning activities. The substantial t value suggests that the difference between groups was not only statistically significant but also educationally meaningful, reflecting the effectiveness of AI chatbots in fostering planning, monitoring, and self-evaluation processes in learning.

A similar pattern was observed in the analysis of learning outcomes. The independent-samples t-test demonstrated a significant difference in posttest academic achievement between the experimental and control groups, as shown in table 4. The results indicated that the experimental group outperformed the control group in Islamic education achievement, with $t(62) = 5.14$ and $p < 0.001$. This finding suggests that AI chatbot integration contributed positively to students' understanding and mastery of instructional content, enabling them to achieve higher academic performance compared to peers receiving teacher-centered instruction.

Taken together, these results provide strong empirical evidence that the integration of AI chatbots had a positive and statistically significant effect on both self-regulated learning and learning outcomes. While the SRL findings highlight the role of AI chatbots in supporting metacognitive and motivational dimensions of learning, the learning outcomes results demonstrate that these improvements translated into tangible academic gains.

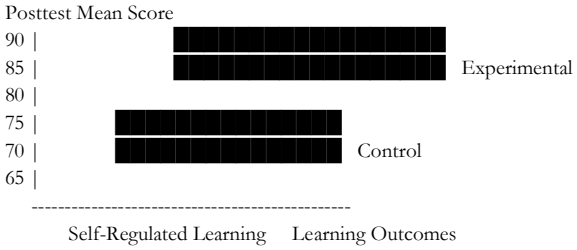

Figure 4. Comparison of Posttest Mean Scores Between Experimental and Control Groups

To enhance interpretability, figure 4 visually compares the posttest mean scores of the experimental and control groups for both variables. The figure illustrates a clear performance gap favoring the experimental group, reinforcing the statistical evidence presented in Table 4. This visual representation underscores the consistency of the findings across cognitive (learning outcomes) and metacognitive (SRL) domains. The comparative analysis confirms that AI chatbot–supported instruction constitutes an effective pedagogical approach in Islamic education, as it simultaneously enhances students' capacity for self-regulated learning and improves their academic achievement.

Relationship Between Self-Regulated Learning and Learning Outcomes

To further examine the role of self-regulated learning (SRL) in students' academic achievement, a Pearson product–moment correlation analysis was conducted using posttest data from the experimental group. This analysis aimed to determine the extent to which students' self-regulatory capacities were associated with their learning outcomes following AI chatbot–supported instruction.

Table 5. Pearson Correlation Between Self-Regulated Learning and Learning Outcomes (Experimental Group)

Variables	*r*	Sig. (*p*)	Interpretation
Self-Regulated Learning – Learning Outcomes	0.68	< 0.001	Strong Positive Correlation

As presented in table 5, the correlation analysis revealed a strong and positive relationship between students' self-regulated learning and their learning outcomes. The results indicated a correlation coefficient of $r = 0.68$ with a significance level of $p < 0.001$. This statistically significant finding suggests that students who demonstrated higher levels of self-regulation—such as effective goal setting, strategic planning, self-monitoring, and reflective evaluation—tended to achieve higher academic performance in Islamic education.

The magnitude of the correlation coefficient indicates a strong association, implying that SRL plays a substantial role in explaining variations in students' learning outcomes within the experimental group. This finding reinforces the notion that academic achievement is not solely determined by instructional content or teaching methods, but is also closely linked to students' ability to regulate their own learning processes. In the context of AI chatbot–supported instruction, students who actively engaged with the chatbot for clarification, feedback, and independent exploration appeared to benefit more academically due to their enhanced self-regulatory behaviors.

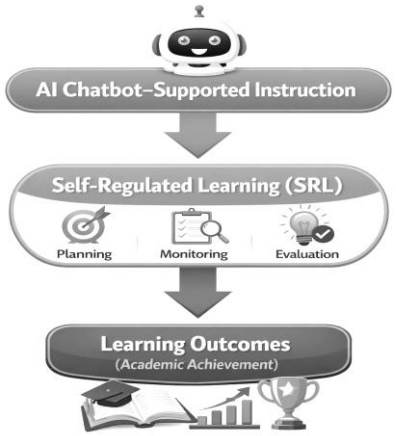

Figure 5. Conceptual of the Relationship Between Self-Regulated Learning and Learning Outcomes

To facilitate interpretation, figure 5 presents a conceptual visualization of the relationship between self-regulated learning and learning outcomes. The diagram illustrates that improvements in SRL are closely aligned with increases in academic achievement, highlighting SRL as a mediating mechanism through which AI chatbot–supported instruction contributes to improved learning outcomes. These findings indicate that AI chatbot–supported instruction not only enhances students' learning outcomes directly, but also strengthens their self-regulated learning skills, which are strongly associated with academic success. The strong correlation between SRL and learning outcomes provides empirical

support for the pedagogical value of integrating AI chatbots into Islamic secondary education contexts, particularly as a means of fostering independent, reflective, and high-achieving learners.

Discussion

The present study investigated the effects of integrating AI-powered chatbots into Islamic education on students' self-regulated learning (SRL) and learning outcomes at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung. The discussion section interprets the empirical findings by situating them within established theories of self-regulated learning, contemporary research on AI-supported instruction, and prior studies in Islamic education. Overall, the findings demonstrate that AI chatbot–supported instruction exerts a significant and meaningful influence on both students' self-regulatory capacities and their academic achievement.

AI Chatbots and the Enhancement of Self-Regulated Learning

The descriptive and inferential results indicate that students in the experimental group experienced a substantially greater improvement in self-regulated learning compared to those in the control group. The large gain score in SRL and the statistically significant posttest differences confirm that AI chatbot–supported instruction effectively fosters learners' ability to plan, monitor, and evaluate their learning processes. This finding is consistent with Zimmerman's social-cognitive model of self-regulated learning, which emphasizes the cyclical interaction between forethought, performance, and self-reflection phases in successful learning.[25] AI chatbots appear to function as external scaffolds that support each of these phases by providing immediate feedback, prompting reflection, and encouraging goal-oriented learning behaviors.

These findings align with recent systematic reviews indicating that educational chatbots can enhance SRL by offering personalized prompts, adaptive feedback, and continuous access to learning support.[26] In the present study, the chatbot-assisted environment likely reduced students' dependence on teacher-centered instruction and encouraged more autonomous engagement with learning materials. This autonomy is particularly relevant in Islamic education contexts, where learners are expected not only to acquire religious knowledge but also to internalize values of responsibility, discipline, and self-improvement.[27]

Moreover, the strong SRL gains observed in the experimental group resonate with studies conducted in both general and Islamic educational settings, which emphasize that technology-enhanced learning environments can promote metacognitive awareness and

[25] Barry J. Zimmerman, "Investigating Self-Regulation and Motivation: Historical Background, Methodological Developments, and Future Prospects," *American Educational Research Journal* 45, no. 1 (2008): 166–183, https://doi.org/10.3102/0002831207312909

[26] Rui Guan et al., "How Educational Chatbots Support Self-Regulated Learning? A Systematic Review of the Literature," *Educational Information Technologies* 30 (2025): 4493–4518, https://doi.org/10.1007/s10639-024-12881-y

[27] Asrori, *Psikologi Pendidikan: Pendekatan Multidisipliner* (Banyumas: Pena Persada, 2020).

strategic learning behaviors.[28] The findings suggest that AI chatbots act as metacognitive partners rather than mere information providers, thereby supporting students' transition from passive recipients of instruction to active, self-regulated learners.

Impact of AI Chatbots on Learning Outcomes in Islamic Education

In addition to improving SRL, the integration of AI chatbots resulted in significantly higher learning outcomes for students in the experimental group. The substantial difference in posttest scores and gain scores between groups indicates that AI chatbot–supported instruction enhances not only how students learn but also what they achieve academically. This finding supports prior research demonstrating that AI-driven personalized learning environments can improve comprehension, retention, and application of instructional content.[29]

From a pedagogical perspective, AI chatbots likely contributed to improved learning outcomes by offering immediate clarification of concepts, reinforcing key ideas, and enabling students to revisit learning materials at their own pace. Such features are particularly beneficial in Islamic education, where abstract theological concepts and moral teachings often require repeated explanation and contextualization.[30] The present findings corroborate earlier studies in Islamic education that reported improved learning outcomes when innovative, student-centered instructional strategies were employed.[31]

Furthermore, these results are consistent with broader empirical evidence suggesting that AI-enhanced instruction can outperform conventional teaching approaches when appropriately aligned with learning objectives and student needs.[32] The findings thus reinforce the argument that AI chatbots, when pedagogically integrated rather than used as stand-alone tools, can serve as effective instructional supports that enrich learning experiences in religious education settings.

The Relationship Between Self-Regulated Learning and Learning Outcomes

One of the most significant findings of this study is the strong positive correlation between self-regulated learning and learning outcomes within the experimental group. The

[28] Ahmad Faza, and Ilyana Agri Lestari. "Self-Regulated Learning in the Digital Age: A Systematic Review of Strategies, Technologies, Benefits, and Challenges." *The International Review of Research in Open and Distributed Learning* 26, no. 2 (2025): 23–58. https://doi.org/10.19173/irrodl.v26i2.8119.

[29] Elkot, Mohamed Ali, Abdalilah Alhalangy, Mohammed Abd Algane, and Rabea Ali. "Pedagogical Influence of AI-Chatbots on Learning Outcomes: A Systematic Review." *International Journal of Educational Methodology* 11, no. 4 (2025): 527–540. https://doi.org/10.12973/ijem.11.4.527.

[30] Ridlwan, M., and Asrori Asrori. "Problems of Implementation of Islamic Religious Education at Muhammadiyah Junior High School 4 Gadung Surabaya." In *International Conference on Islamic and Muhammadiyah Studies (ICIMS 2022)*, 312–318. Amsterdam: Atlantis Press, 2022. https://doi.org/10.2991/assehr.k.220708.039.

[31] Abbas Lumbilsa, A. Asrori, and R. Rusman. "Improving Creativity and Learning Outcomes Through Team-Assisted Individualization Learning Islamic Education Lessons." *EDUKASI: Jurnal Pendidikan Islam* 11, no. 2 (2023): 199–213. https://doi.org/10.54956/edukasi.v11i2.371

[32] Makarenko, Oleksandr, Oleksandra Borysenko, Tetiana Horokhivska, Vladyslav Kozub, and Daryna Yaremenko. "Embracing Artificial Intelligence in Education: Shaping the Learning Path for Future Professionals." *Multidisciplinary Science Journal* 6 (2024). https://doi.org/10.31893/multiscience.2024ss0720.

correlation coefficient indicates that students who demonstrated higher levels of SRL tended to achieve better academic results. This finding aligns with a substantial body of literature highlighting SRL as a key predictor of academic success across educational levels and disciplines.[33, 34]

The strong association observed in this study suggests that SRL may function as a mediating mechanism through which AI chatbot–supported instruction influences learning outcomes. By strengthening students' ability to regulate their learning, AI chatbots indirectly contribute to improved academic performance. This interpretation is consistent with prior meta-analytical and empirical studies demonstrating that interventions targeting SRL often yield significant gains in achievement.[35]

In the context of Islamic education, this relationship is particularly meaningful. Islamic pedagogical traditions emphasize intentionality (*niyyah*), self-discipline (*mujāhadah*), and continuous self-evaluation (*muḥāsabah*), all of which closely correspond to core components of self-regulated learning.[36] The integration of AI chatbots thus represents a contemporary technological means of reinforcing these longstanding educational values, bridging classical Islamic pedagogy with modern digital learning environments.

Implications for Islamic Education and AI-Supported Pedagogy

Taken together, the findings suggest that AI chatbot–supported instruction offers a promising pedagogical approach for Islamic secondary education. By simultaneously enhancing SRL and learning outcomes, AI chatbots support the development of learners who are not only academically competent but also capable of independent and reflective learning. This aligns with current calls for the integration of technology in Islamic education in ways that preserve religious values while addressing contemporary educational challenges.[37]

However, the findings also imply that the effectiveness of AI chatbots depends on thoughtful pedagogical design. Without intentional integration into instructional activities, AI tools may fail to promote meaningful learning or self-regulation.[13] Therefore, educators should view AI chatbots as complementary instructional partners that support, rather than replace, the role of teachers in guiding students' cognitive, moral, and spiritual development.

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[33] Paul R. Pintrich et al., *A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)* (Ann Arbor: University of Michigan, 1991).

[34] Asrori, Miftachul Huda, M. Febriyanto Firman Wijaya, Agus Budiman, Masulah, Sandha Soemantri, Muhammad Muzakki, Arif Pramana Aji, and Zulkifli, "Systematic Design of Online Material Resources for Learning Instruction: A Critical Review," in *Information Systems for Intelligent Systems*, edited by Antonio Iglesias, Jihoon Shin, Nikhil Bhatt, and Amit Joshi, ISBM 2025, *Lecture Notes in Networks and Systems*, vol. 1748 (Cham: Springer, 2026), https://doi.org/10.1007/978-3-032-12990-1_38

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Limitations and Directions for Future Research

Despite its contributions, this study has several limitations. The sample was limited to a single junior high school, which may constrain the generalizability of the findings. Future studies could involve multiple institutions and diverse student populations to strengthen external validity. Additionally, longitudinal research is needed to examine whether the observed improvements in SRL and learning outcomes are sustained over time. Qualitative investigations may also provide deeper insights into students' lived experiences and perceptions of AI chatbot–supported learning in Islamic education contexts.

CONCLUSION

This study demonstrates that integrating AI-powered chatbots into Islamic education at SMP IT Pondok Tahfizh Qur'an Kepulauan Bangka Belitung has a significant positive effect on students' self-regulated learning (SRL) and learning outcomes. Students who participated in AI chatbot–supported instruction showed substantially higher gains in planning, monitoring, and evaluating their learning, which were accompanied by improved academic achievement compared to those receiving conventional teacher-centered instruction. The strong positive relationship between SRL and learning outcomes indicates that enhanced self-regulation serves as a key mechanism through which AI chatbots contribute to academic improvement. The findings support self-regulated learning theory and suggest that AI chatbots function effectively as pedagogical scaffolds that promote learner autonomy and reflective learning. Importantly, the results also highlight the compatibility of AI-supported instruction with Islamic educational values, such as intentionality, discipline, and self-evaluation. Overall, this study provides empirical evidence that AI chatbot–supported instruction represents a promising and contextually appropriate pedagogical approach for Islamic secondary education. While the findings are limited to a single junior high school, they offer a foundation for future research involving broader contexts, longitudinal designs, and deeper exploration of ethical and pedagogical considerations in AI integration within Islamic education.

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