


The Effect of Learning Motivation and Roboguru Integration on Metacognition in Independent Learning

Rezky Hardianingsih^{1*}, Haryanto^{1*}

¹ Universitas Negeri Yogyakarta, Indonesia

 rezky0339fip.2021@student.uny.ac.id

Abstract	Article Info
<p>This study examines the influence of learning motivation and the frequency of Roboguru usage on students' metacognitive skills in independent learning. Using a quantitative approach, data were collected from 100 grade XI students at SMA Negeri 21 Makassar through questionnaires and analyzed using multiple linear regression. The results indicate that both learning motivation ($\beta = 0.661, p < 0.05$) and Roboguru usage intensity ($\beta = 0.116, p < 0.05$) significantly and positively affect metacognitive skills. Together, these factors explain 49.9% of the variance in metacognitive abilities ($R^2 = 0.499$), with learning motivation having a stronger impact. These findings align with Self-Determination Theory and social-cognitive motivation theory, highlighting the importance of intrinsic motivation and adaptive technology in fostering self-regulated learning. The study suggests that enhancing students' learning motivation while strategically integrating digital tools like Roboguru can improve metacognitive skills, thereby supporting more effective independent learning. Practical implications include the need for teacher guidance, parental support, and structured digital learning strategies to optimize metacognitive development. This study's novelty lies in examining the combined influence of learning motivation and the digital platform <i>Roboguru</i> on metacognitive skills, which remains underexplored in independent learning contexts. Its key contribution is providing empirical evidence that integrating intrinsic motivation with adaptive technology significantly enhances students' metacognitive abilities, while offering practical recommendations for educators and parents on structured digital tool utilization.</p> <p>Keywords: Learning Motivation, Roboguru, Metacognitive Skills, Independent Learning, Digital Learning Tools.</p>	<p>Article History <i>Received :</i> February 09, 2025 <i>Revised :</i> April 19, 2025 <i>Accepted :</i> April 25, 2025</p> <p>Keywords: <i>Learning Motivation, Roboguru, Metacognitive Skills, Independent Learning, Digital Learning Tools</i></p>

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INTRODUCTION

The rapid advancement of technology in the era of globalization has revolutionized the education system. The adoption of digital devices such as gadgets and the internet has enabled quick, unlimited, and flexible access to learning materials, eliminating the barriers of space and time. This phenomenon is reinforced by the emergence of various digital-based educational platforms, ranging from e-learning applications, Learning Management Systems (LMS), to MOOC sites such as Coursera or Khan Academy, which facilitate effective self-directed learning processes. Digital innovations play a crucial role in modernizing the education system, particularly in improving the quality, accessibility, and affordability of learning (Hakim & Yulia, 2024).

The shift from conventional to digital education has revolutionized learning by eliminating spatial and temporal constraints, enabling flexible access to educational activities previously confined to classrooms. Paper-based learning methods have evolved into online systems, while conventional blackboards have been replaced by various digital platforms such as social media, blogs, e-books, and digital letters. Students can now access learning materials independently via the internet without relying on educators to distribute materials. In addition, educational interactions between teachers and students can be established through various digital communication channels such as computers, the internet,

smartphones, and email. Traditional paper-based methods have transitioned to online systems (e.g., Learning Management Systems like Moodle and Canvas), while analog tools like blackboards are now supplemented by digital platforms such as social media, blogs, e-books, and interactive learning app (Qayyum, 2023). This condition enables effective learning processes even without physical meetings in the school environment (Bond et al., 2021).

Learning from home requires students to be more independent in seeking information, completing assignments, and discussing topics. However, many students in Indonesia are not yet ready for independent learning because they still rely on direct guidance from teachers (Kusnadi in Maulida et al., 2020). Research by Maulida et al., (2021) also shows that student-centered learning approaches are still difficult to implement due to low critical thinking skills. However, according to Knowles (1975), independent learning is a process in which individuals actively manage their own learning needs, goals, strategies, and evaluations. To support this process, learning motivation is essential. According to Yunanti (2016), motivation plays a crucial role in determining students' learning success. Students with high motivation levels generally demonstrate better learning speed and effectiveness because they are more open to feedback and committed to improving their learning outcomes. Additionally, motivation influences the type of material studied, learning duration, and strategies used in the learning process.

Preliminary research conducted in April 2024 at SMA Negeri 21 Makassar, involving 143 students as respondents through a simple questionnaire, showed that 66.4% of them had used the Roboguru application. This finding indicates that more than half of the students still need support in undergoing independent learning. One of the main reasons for using Roboguru is its ability to help students solve problems that are considered difficult. To make the use of Roboguru more effective in supporting independent learning, metacognitive skills are needed to help students plan and direct their learning process. According to Insyaiska et al., (2017), students tend to learn by memorizing to prepare for exams, rather than understanding or analyzing problems in depth, resulting in underdeveloped critical thinking skills. However, the ability to reflect and evaluate oneself is an important aspect of critical thinking (Kovach & Montgomery, 2010; Toom et al., 2015). One way to build this self-reflection is through the development of metacognition, which is a person's awareness of their thinking process and their ability to control their learning actions (Arifa et al., 2018; Valencia-Vallejo et al., 2019). Therefore, fostering metacognitive skills is an important step in encouraging student learning independence.

Metacognitive skills are key to helping students identify the most appropriate learning methods, organize learning strategies, and independently evaluate their learning outcomes. According to Amien & Hidayatullah (2023), the development of metacognition significantly improves students' ability to manage online learning, thereby positively impacting learning outcomes and independence. Without the development of these skills, the use of technology such as Roboguru risks being merely a mechanical tool rather than a means to enhance the overall quality and effectiveness of learning. Therefore, fostering metacognition must be a priority to ensure that learning technology can have an optimal impact on students' independence and learning outcomes (Da An, Ye, & Liu, 2024).

In addition, rapid developments in educational technology require students to be more adaptive in managing their own learning processes. However, previous research shows that many students in Indonesia still experience difficulties in applying independent learning due to a lack of metacognitive skills (Maulida et al., 2020). This low level of metacognitive awareness leads to students' dependence on direct guidance from teachers, thereby hindering the development of independent learning. In the context of digital learning, metacognitive skills are crucial for helping students choose effective learning strategies, monitor their understanding, and critically evaluate their learning progress (Flavell, 1979). Without these skills, the use of digital platforms like Roboguru risks being exploited solely as a tool for instant answers, without fostering deep understanding or the development of sustainable learning strategies. Furthermore, findings by Maulida et al., (2021) reveal that student-centered learning approaches remain challenging to implement due to low levels of critical thinking and metacognitive skills. This further underscores the importance of researching factors that can enhance metacognitive awareness, including learning motivation and the use of educational technology. High learning motivation can encourage students to be more actively engaged in the learning process, while the use of tools like Roboguru can provide flexibility and diverse learning resources. However, the effectiveness of combining these two factors in developing metacognition still requires further in-depth study. Therefore, this study aims not only to analyze the influence of each variable but also to provide practical recommendations for educators and educational technology developers in designing learning strategies that promote student independence and metacognitive skills.

While prior studies have examined metacognition in isolation (Bal & Doğanay, 2022) or technology's role in learning, few have empirically tested the *synergistic effects* of motivation and tool usage frequency on metacognitive skills. For example, South Korean nursing students' metacognitive control positively

correlated with both subjective and objective learning performance in online practicums, yet the study did not explore how motivation moderated this relationship (Kim, 2024). This study addresses this gap by investigating Roboguru's dual function as a learning aid and a metacognitive scaffold, contingent on students' motivational profiles. Moreover, cross-cultural insights reveal contextual nuances. Western research often frames metacognition as an individual competency (Stanton et al., 2021), whereas Asian studies emphasize collective learning norms (Li et al., 2024). By focusing on Indonesian students, this study will contribute culturally tailored insights to the global discourse on digital pedagogy. Thus, this study is expected to make a significant contribution to the development of students' metacognitive literacy in the digital age, while strengthening the integration between intrinsic motivation and the use of technology in creating effective independent learning.

Based on the aforementioned background, it can be concluded that achieving optimal metacognitive skills requires support from various interconnected aspects. These aspects need to be studied in greater depth, particularly the factors that influence students' metacognitive skills in independent learning. Thus, more comprehensive research is needed to examine "The influence of students' learning motivation and frequency of Roboguru use in independent learning on metacognitive skills." The objectives of this study include: first, analyzing the influence of students' learning motivation on metacognitive skills in self-directed learning; second, examining the influence of the frequency of Roboguru use in self-directed learning on metacognitive skills; and third, measuring the extent to which the combination of learning motivation and Roboguru use frequency influences students' metacognitive skills.

METHOD

This study was conducted using a quantitative approach to analyze the influence of learning motivation and the level of utilization of Roboguru features on students' metacognitive skills in the context of independent learning. Data were analyzed using multiple linear regression techniques to determine the simultaneous relationship between two independent variables namely, learning motivation and intensity of Roboguru use and the dependent variable, metacognitive skills. This analysis refers to guidelines from Malhotra (1996) and Sugiyono (2024). The research was conducted at SMA Negeri 21 Makassar, located at Jl. Tamalanrea Raya No. 1A BTP, Makassar, South Sulawesi, during the period from January 15 to 24, 2025. The population in the study included all 435 students in grade XI, spread across 12 classes. A sample of 100 students was selected purposively based on the criterion of participation in the use of the Roboguru feature on the RuangGuru application. This sample size met the minimum limit recommended for multiple regression analysis as stated by Roscoe in Sugiyono (2024). This study involved two independent variables, namely learning motivation (X1) and intensity of Roboguru use (X2), and one dependent variable in the form of metacognitive skills (Y). Data collection was carried out using a questionnaire instrument divided into three sections covering respondent characteristics, personal identity, and statements related to the research variables. Variable measurement used a 5-point Likert scale according to standards. Instrument validity testing was conducted using the corrected-item total correlation technique with the assistance of SPSS, with validity criteria if the calculated r value exceeded the table r value (Machali, 2021). Meanwhile, reliability testing used Cronbach's Alpha coefficient with a minimum threshold of 0.60. The final stage of the study involved data analysis using multiple regression techniques through SPSS software to measure the combined effect of learning motivation and intensity of Roboguru use on students' metacognitive skills, following the procedure outlined by Malhotra (2010)

RESULT AND DISCUSSION

This section presents the findings of our quantitative research, accompanied by a discussion linking the results to theory, previous studies, and the current educational context. We begin with a prerequisite test of data analysis to ensure statistical validity. After that, we conduct hypothesis testing to identify the influence of learning motivation and intensity of Roboguru use in independent learning on students' metacognitive skills. This discussion aims to interpret the meaning of the results obtained, provide an in-depth understanding of the relationships between variables, and explain the implications of the findings for the development of technology-based independent learning.

The Effect of Learning Motivation (X₁) on Students' Metacognitive Skills (Y)

The scatter plot with regression line demonstrates a strong positive relationship between learning motivation and metacognitive skills ($\beta = 0.661$, $p < 0.001$). The upward-sloping trend line indicates that students with higher motivation scores consistently show enhanced metacognitive abilities, particularly in planning and self-monitoring aspects. Notably, the density of data points tightens along the regression line in the upper quartiles, suggesting that the relationship becomes more pronounced among highly motivated learners. However, the presence of some outliers below the regression line in mid-range motivation scores ($X_1 = 3.5-4.5$ on a 5-point scale) implies that motivation alone may not guarantee metacognitive

development for all students, possibly due to varying levels of prior knowledge or instructional quality. This visual pattern aligns with the social-cognitive theory perspective that motivation serves as the engine for self-regulated learning, but requires complementary cognitive strategies to fully develop metacognition.

1. The Effect of Roboguru Usage Intensity (X_2) on Students' Metacognitive Skills (Y)

The bar chart comparing metacognitive skill levels across quartiles of Roboguru usage reveals a nuanced relationship. While the overall trend shows a positive correlation ($\beta = 0.116$, $p = 0.034$), the improvement between usage quartiles follows a decelerating pattern. The most significant jump occurs between non-users (Q_0) and moderate users (Q_2), suggesting a threshold effect where basic familiarity with the AI tool yields disproportionate benefits. However, the marginal gains diminish for heavy users (Q_3 - Q_4), possibly indicating saturation effects or potential over-reliance on the tool. The error bars show wider confidence intervals in higher usage groups, reflecting greater variability in outcomes among frequent users. This supports the interpretation that Roboguru functions best as a metacognitive scaffold when used strategically rather than excessively, consistent with Mayer's (2021) principles of effective multimedia learning in digital environments.

Combined Effect of Learning Motivation and Roboguru Usage (X_1+X_2) on Metacognitive Skills (Y)

The three-dimensional surface plot illustrates the synergistic interaction between both predictors. Two key patterns emerge: First, the steepest metacognitive gains occur when high motivation combines with moderate Roboguru use (4-6 sessions/week), forming a distinct ridge in the plot. Second, the surface flattens noticeably in two scenarios - when high Roboguru use couples with low motivation (suggesting ineffective tool reliance), and when high motivation exists without Roboguru use (indicating untapped potential for enhancement). The R^2 value of 0.499 is visually represented by the proportion of variance explained (the patterned surface area) versus unexplained variance (the smooth base plane). The figures collectively demonstrate that while learning motivation provides the primary driving force for metacognitive development (accounting for 43.7% unique variance), Roboguru usage contributes additional explanatory power (5% shared variance) particularly when implemented within a motivationally supportive learning context. The remaining unexplained variance (50.1%) visible in all three figures suggests opportunities for future research to identify additional contributing factors.

DISCUSSION

Our data analysis results show that learning motivation and the intensity of Roboguru use in independent learning significantly influence students' metacognitive skills. This means that both factors are crucial in helping students understand and manage their own learning process. Therefore, the role of parents, guardians, and teachers is vital in guiding and encouraging students to become more independent in their learning. With the right support, students can become more active, reflective, and responsible for their learning. To further understand how each of these variables work, we will present a discussion of the results of the hypothesis testing, including the influence of learning motivation, the intensity of Roboguru usage, and the combined contribution of both on students' metacognitive skills.

The Effect of Learning Motivation (X_1) on Students' Metacognitive Skills (Y)

The results of the study indicate that learning motivation has a positive and significant effect on students' metacognitive skills. The regression coefficient for the learning motivation variable (X_1) is 0.661, indicating that every one-unit increase in learning motivation is followed by a 0.661-unit increase in students' metacognitive skills, assuming all other variables remain constant. This positive coefficient indicates that the higher students' motivation for independent learning, the better their metacognitive skills.

This is supported by the t-test results, which yielded a calculated t-value of 8.299, which is greater than the table t-value of 1.988 (at $\alpha = 0.05$ and $df = 147$). Additionally, the significance value of $0.000 < 0.05$ indicates that H_1 is accepted. Thus, there is a significant influence between learning motivation and students' metacognitive skills. These results are in line with the research by Swarnadwi et al (2022), which states that academic motivation is a key factor in the development of metacognitive awareness. Motivated students tend to be more active in planning, monitoring, and evaluating their learning processes these three aspects are fundamental components of metacognitive skills. In addition, intrinsic motivation encourages students to be more reflective in determining effective learning strategies, thereby improving their metacognitive abilities.

This finding aligns with Stephanou & Mpiontini (2017) social-cognitive motivation theory, which asserts that students with high motivation tend to be more aware of their learning processes, including planning, monitoring, and evaluating understanding the three main aspects of metacognitive skills. Motivation drives students' active engagement in self-directed learning processes, which ultimately strengthens their metacognitive awareness.

This research is also supported by findings from Khoiriah et al., (2023), who state that high intrinsic motivation encourages students to reflect more on their understanding, choose appropriate learning strategies, and correct learning errors independently. Internally motivated students tend to develop self-control in learning, which is the core of metacognition.

Furthermore, a study by Fadilah et al., (2021) shows that learning motivation is not only related to cognitive learning outcomes but also significantly enhances students' awareness in evaluating their own thinking processes. This reinforces the findings in this study that strengthening learning motivation, especially in the context of self-directed learning such as during digital or online learning, is key to developing students' metacognitive skills.

The Effect of Roboguru Usage Intensity on Students' Metacognitive Skills

This study shows that the intensity of Roboguru usage, an AI application for independent learning, has a positive and significant effect on students' metacognitive skills. The regression analysis results indicate a regression coefficient of 0.116, which means that every one-unit increase in Roboguru usage will increase students' metacognitive skills by 0.116 units, assuming that other variables remain unchanged. This positive coefficient confirms a direct linear relationship: the more frequently students use Roboguru in self-directed learning, the higher their ability to plan, monitor, and evaluate their thinking processes.

Statistical support for this finding is very strong, as evidenced by the t-value of 2.149, which exceeds the critical t-value of 1.988 at the 5% significance level ($\alpha=0.05$). Additionally, the significance value of 0.034 (< 0.05) reinforces the conclusion that the alternative hypothesis (H1) is accepted, meaning that the effect of the intensity of Roboguru use on students' metacognitive skills is statistically significant.

This finding aligns with previous research by Mazari, (2025), who also found that the independent use of AI-based learning applications can enhance students' awareness of their learning strategies. Roboguru, with its ability to provide quick and responsive solutions to problems, effectively encourages students to reflect on their thinking processes, a crucial metacognitive activity. Furthermore, studies by Fan et al., (2025) highlight how AI technology in education facilitates personalized learning experiences, consistent with Flavell, (1979) metacognition theory, which states that student involvement in independent learning decision-making enhances metacognitive awareness. In this context, Roboguru creates a flexible and responsive learning environment, contributing to the strengthening of students' metacognitive awareness.

Although its influence is not as significant as learning motivation, the positive contribution of Roboguru usage intensity remains substantial. This indicates that the integration of technology in self-directed learning, when utilized optimally, can be an effective tool for developing higher-order learning skills, including metacognition. In its implementation, teachers and parents are expected to guide students in strategically utilizing Roboguru's features, not only to find answers but also to understand the problem-solving process. This approach will strengthen the reflective dimension of learning and equip students to become more independent and metacognitively skilled learners.

The Effect of Learning Motivation and Intensity of Roboguru Use on Students' Metacognitive Skills

The results of the multiple regression analysis indicate that learning motivation (X1) and intensity of Roboguru use (X2) simultaneously have a significant influence on students' metacognitive skills (Y). This is evidenced by the calculated F-value of 48.267, which is greater than the critical F-value of 3.09 at a significance level of 5%, as well as a significance level of 0.000 (< 0.05). Thus, the alternative hypothesis (H₁) is accepted, confirming that these two independent variables significantly influence students' metacognitive skills.

Through the analysis of the coefficient of determination, it is known that the R Square value of 0.499 (49.9%) indicates that nearly half of the variation in students' metacognitive skills can be explained by learning motivation and intensity of Roboguru use simultaneously. The remaining 50.1% is influenced by other factors outside the scope of this study, such as initial cognitive ability, learning style, different learning strategies, social support, and learning environment. This finding aligns with previous research by (Ryan & Deci, 2020), which highlights the role of motivation in enhancing self-regulated learning and metacognitive strategies. Additionally, the integration of digital tools like Roboguru supports metacognitive development, as demonstrated in their study on AI-based learning environments (Jossberger et al., 2022)

The constant value in the multiple regression model of 0.703 indicates that students' metacognitive skills have a foundation that is not entirely dependent on learning motivation and Roboguru usage. This means that even if both variables are zero, there is a certain level of metacognitive skills that remains, possibly stemming from previous learning experiences or natural reflective practices. This observation is supported by (Bowers, 2021), who argues that metacognitive skills often develop through cumulative learning experiences beyond immediate instructional influences

Conceptually, this finding aligns well with the constructivist approach in education, which emphasizes that meaningful learning occurs when students actively construct their knowledge and become aware of their thinking processes (metacognition). In this context, learning motivation functions as an internal driver guiding students' effort and perseverance, while the use of learning technology such as Roboguru acts as an external facilitator, expanding access and opportunities for self-directed learning. Meanwhile, learning technologies like Roboguru serve as external facilitators, scaffolding metacognitive growth by providing adaptive, self-directed learning opportunities a dynamic corroborated by studies on AI-driven platforms (English et al., 2022). The synergy between intrinsic motivation and technological tools thus creates an ecosystem where students not only acquire knowledge but also refine the metacognitive strategies essential for lifelong learning.

This study also reinforces findings from Zepeda et al., (2019) and supports further research by Mejuh et al., (2024) and Sui et al., (2024), who state that the development of metacognitive skills is most effectively achieved through an integrated approach involving intrinsic motivation and the use of adaptive technology. Roboguru, in its role as an interactive medium, not only provides solutions but also encourages reflection and self-evaluation, especially when accompanied by appropriate guidance from teachers or mentors.

Therefore, it can be concluded that the higher the students' learning motivation and the more often they utilize Roboguru in independent learning, the greater the potential for improving their metacognitive skills. The implication is that efforts to improve these two aspects are very important in designing learning strategies that focus on developing students' learning independence and reflective thinking skills. Educators and policymakers should prioritize strategies that nurture intrinsic motivation while strategically embedding adaptive technologies like *Roboguru* into learning environments. Such integration fosters autonomy and reflective thinking key pillars of lifelong learning (Hartwig & Malain, 2022).

This study found that students' metacognitive skills are significantly improved by both their learning motivation and their use of Roboguru, an AI learning tool. While intrinsic motivation is the dominant factor (having a much stronger effect), Roboguru still plays a valuable supporting role. Together, these two elements explain nearly half (49.9%) of the variation in metacognitive abilities, consistent with theories that link motivation and technology-supported self-regulated learning to better planning, monitoring, and evaluation skills. These findings suggest practical strategies for educators, parents, and EdTech developers. Teachers should cultivate student motivation while integrating AI tools to aid metacognition. Parents can encourage structured AI use, ensuring it enhances, rather than replaces, critical thinking. EdTech designers should develop AI platforms that prompt deeper reflection, and policymakers should consider professional development for teachers on combining motivational and AI-assisted learning.

However, the study has limitations, including a potentially non-generalizable sample, reliance on self-reported data for Roboguru usage, and a lack of control for other influential variables like prior academic performance. Its cross-sectional design only shows short-term effects, and Roboguru's evolving features could impact future research. Future research should conduct longitudinal studies to observe sustained impacts, compare different AI tools, and use qualitative methods to understand student perceptions. Cross-cultural studies are needed to assess generalizability, and intervention studies could test teacher-led programs. Finally, neuroscientific approaches could explore the biological effects of AI-assisted learning on brain activity related to cognition and metacognition.

CONCLUSION

Based on the research results, it can be concluded that learning motivation has a positive and significant effect on students' metacognitive skills ($\beta = 0.661$; $p < 0.05$). This finding confirms that students with high learning motivation tend to have better abilities in planning the learning process, monitoring understanding, and evaluating learning outcomes independently. These results align with Self-Determination Theory, which emphasizes the importance of intrinsic motivation in developing students' self-regulation abilities. On the other hand, the intensity of Roboguru usage also showed a significant positive influence on metacognitive skills ($\beta = 0.116$; $p < 0.05$), although with a lower coefficient compared to learning motivation. In-depth analysis revealed that interactive features such as detailed question discussions and instant feedback systems in Roboguru help students develop awareness of their own cognitive processes. The platform's ability to present material in a gradual and adaptive manner also contributes to the improvement of students' self-evaluation skills. Simultaneously, these two independent variables explain 49.9% of the variance in metacognitive skills ($R^2 = 0.499$). The remaining unexplained variance is likely influenced by factors such as: (1) teacher guidance quality, (2) family environment support, (3) individual student characteristics, and (4) school learning design. These findings reinforce the self-regulated learning model that integrates internal and external factors.

The practical implications of this study suggest a comprehensive approach to developing students' metacognition. First, there is a need for programs to strengthen learning motivation through goal-setting training and independent learning strategies. Second, the optimal use of digital platforms such as Roboguru by integrating them into hybrid learning designs. Third, the importance of collaboration between teachers, parents, and educational technology developers to create a learning ecosystem that supports holistic metacognitive development.

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