

Research Article

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Promoting Learners' Autonomy through Metacognitive, Higher-Order Thinking Skills and Digital Literacy of Indonesian Private Universities

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Abstract

Background/purpose. With expanding technology and globalization, the educational system must teach students academic knowledge and in-depth practical skills, including critical and independent thinking. This study aims to investigate how learner autonomy affects higher-order thinking skills, metacognition, and digital literacy in Indonesian private universities.

Materials/methods. This study applied a quantitative approach, with a total number of participants of 1.232 students (N=1.232). It employed cluster random sampling to select participants in Indonesian private universities. Multivariate SEM-PLS data analysis was used.

Results. The findings show that the t-test statistic of 2.021 at a 5% significance level ($p < 0.05$) substantiates this positive impact. This indicates that digital literacy (DL) substantially impacts learner autonomy (LAT). Equipping students with SRL, metacognitive methods, and HOTS can augment their autonomy in learning. HOTS (analyze, wise decision, new knowledge connection, creative solution) shows statistically significant effects on students' digital literacy through easy-to-use technology, accurate information, and technology collaboration in use. Improved digital literacy helps students to regulate their learning process and reflect on themselves, hence developing metacognitive namely study reflection, evaluation, special strategy, and own learning strategy. Moreover, metacognitive skills improve learner autonomy, meaning that students with strong self-regulation capacity are more likely to properly monitor and guide their learning.

Conclusion. By improving students' access to, analysis of, and application of knowledge, digital literacy strengthens their critical thinking abilities and self-regulation of learning practices. Recommendation to enhance self-regulated learning strategies and encourage students to critically evaluate, reflect, and make informed academic and professional decisions by identifying these interconnections.

1. Introduction

Students need to gain not just academic information but also complete practical skills, such as critical and independent thinking, for the education system to successfully prepare them for the rapidly advancing technological breakthroughs and globalization that are occurring in the present day (Nurhikmah et al., 2024). University students may lack digital resources and dependable internet access. Inequality hinders digital literacy, which fosters learner autonomy. For fair education, the digital divide must be reduced (Atoy et al., 2020). The advent of information communication technology in education has prompted efforts to enhance the learning environment and develop techniques to cultivate a creative and professional digital generation (Lee et al., 2015). This type of learning necessitates specific approaches; the topics covered include course design, instructional strategies, communication methods utilizing electronic and other technology, as well as distinctive organizational and administrative systems (Zaha, 2022).

This highlighted key aspects of how literacy has evolved to include digital competencies for contemporary students (Durriyah & Zuhdi, 2018). In today's education landscape, digital literacy encompasses not just reading and writing but also the ability to use ICT tools effectively to communicate, collaborate, and navigate information online (Ting, 2015; Alavi et al., 2016). This fluency in digital literacy is crucial as students engage with information in increasingly complex digital environments, where they are expected to access, evaluate, and produce content (Perera, 2018). Digital literacy has become essential for success in academic, professional, and social domains within our knowledge-based society (Prior et al., 2016).

In an educational context, fostering digital literacy means equipping students with skills to handle diverse digital tools, ensuring they can critically analyze information and responsibly contribute to the digital world (Peled, 2021; Götl et al., 2024). The participation of young individuals in digital literacy has consistently risen during the era of information and communication technology (ICT) (Kozina, F., & Metljak, 2022; Agasisti et al., 2023; Hu & Yu, 2023). The urgency of ICT integration highlights the need for educational institutions to invest in technology infrastructure, teacher training, and digital literacy initiatives, ensuring that students are empowered to thrive in an interconnected, digital world (Delgado et al., 2018; Mulyana & Maylawati, 2024; Padilla et al., 2024).

Autonomous learning involves self-initiated ideas and behaviors that are systematically planned based on people's evaluation, reflection, and monitoring to improve participation in strategies for achieving personal objectives (Zenouzagh et al., 2023). Learner autonomy is a pivotal concern in education, influenced by changing workforce requirements, swift technological progress, and an increasing focus on lifelong learning (Zenouzagh et al., 2023). Learner autonomy is very context-dependent and can be molded by various educational settings (Toffoli & Perrot, 2017). Technology-mediated learning materials possess varying potentials for facilitating independent learning (Marboot, Roohani, and Mirzaei, 2020; Lo, 2024). Nevertheless, each teacher and student possesses their own pace in delivering and acquiring knowledge, and particular instructors may withhold things from students, causing some students to experience a sense of urgency (Mariñas et al. 2023; Leino 2014).

Previous study recommendations indicate that implementing platform learning can foster learner autonomy and has produced favorable outcomes in improving students' independent learning skills (Ardi, 2017). Self-regulation strengthens the relationship between digital literacy and academic success in digital textbook-based learning (Lee et al., 2015). Fostering learner autonomy in a computer-based classroom is enhanced by helping students use a blend of cognitive, metacognitive, and social strategies (Koç & Koç, 2016). Fostering metacognitive skills, along with critical thinking and creativity, creates a strong foundation for learner autonomy (Nosratinia & Zaker, 2014).

Much of the current research on learner autonomy, metacognition, and digital literacy has been undertaken in more developed educational settings, where access to technology and educational culture may differ from those at Indonesian private universities. This gap restricts the relevance of current findings to Indonesian students, who may encounter distinct obstacles, opportunities, and effectivity affecting autonomy for Indonesian private university students.

2. Theoretical Framework and Literature Review

Bloom categorized educational aims into three domains: cognitive, emotional, and psychomotor (Littlewood, 1996). The domains are structured hierarchically, similar to other taxonomies, indicating that mastery at higher levels relies on acquiring essential information and abilities at lower levels (Munzenmaier & Rubin, 2013). Bloom's Taxonomy is the primary classification system in education, spanning a range of cognitive capacities that move from fundamental information to sophisticated evaluative judgment (Agih & Agih, 2019; Lu et al., 2021). Before evaluation, students must understand and acquire the requisite skills. Utilizing a variety of teaching approaches and tactics to cultivate higher-order thinking skills, the student will commence the application, analysis, synthesis, and evaluation of new knowledge (Singh & Shaari, 2019).

Moreover, theories regarding metacognition integrate knowledge about cognition and regulation. A somewhat coherent knowledge framework that can explain and predict many empirical phenomena. A methodical knowledge framework, meta-active theory may explain and forecast many cognitive and metacognitive events (Schraw & Moshman, 1995; Kuhn, 2000). Three meta-active theories exist. Tacit theories are developed or gained without conscious knowledge of one having a theory. Growing understanding and management of productive processes define informal, somewhat explicit theories. Formal theories involve explicit theoretical structures and are extensively systematized. Although the three types are ordered chronologically, formal theories are linked to increased education and expertise rather than age (Moshman, 2018).

Digital literacy is increasingly acknowledged as essential for individuals and governments alike, especially for youth who are active digital media users. Research emphasizes its role in enabling young people to access information, participate in shaping public opinion, and engage in decentralized, digital-based communication (Sadaf & Gezer, 2020). Furthermore, autonomy has been a prominent topic of discourse in education. The concept has effectively directed our focus on these challenges and prompted us to examine them rigorously. It has effectively connected conversations around pedagogy with broader discourses regarding education (Littlewood, 1996). Learner autonomy has been significantly emphasized in educational practices and research for over thirty years (Dang, 2012).

This theoretical framework explains how HOTS, metacognition, and digital literacy foster learner autonomy. Their related functions demonstrate how these crucial components help students manage and direct their learning. The framework shows how these talents interact and synergize, helping create innovative instructional methods. This paradigm enables Indonesian private university instructors and policymakers to design programs and activities that promote independent, self-motivated learning in a digital, knowledge-driven environment skill to succeed as self-motivated, independent learners in a digital, informative world.

Although extensive literature exists regarding the advantages of learner autonomy, limited research has examined the synergistic impact of metacognitive skills, HOTS, and digital literacy in fostering autonomy, specifically within the setting of Indonesian private universities. This research seeks to address this gap by examining the impact of these skills on learner autonomy and, therefore, on academic performance and engagement.

2.1. Higher Order Thinking Skill (HOTS)

HOTS enables learners to improve their learning and effectively share their information with others (Singh & Shaari, 2019; Feriyanto & Putri, 2020). Teaching HOTS is essential for fostering students' capacity to think critically, apply knowledge to real-life situations, excel in information technology, and collaborate effectively (Retnawati et al., 2018; Nuong et al., 2022). Although Bloom's Taxonomy and HOTS are significant frameworks for enhancing education, their application necessitates careful attention to contextual, cultural, and systemic variables. An intricate technique would tackle these challenges, guaranteeing that the advantages of these strategies are achieved fairly and efficiently (Ichsan et al., 2019).

2.2. Learner's Autonomy

This theory describes learning autonomy is the ability of students to control their learning process, including making decisions about what they learn, how they learn, and how much they are involved in learning activities. With the advancement of technology and its integration into education, most educational paradigms have transitioned from focusing on instructors and pedagogical methods to emphasizing learners and enhancing their autonomy through innovative technological tools (Loi, 2017). Autonomy is when learners are dedicated and accountable for their education, hence pursuing new knowledge independently (Toffoli & Perrot, 2016; Danilenko et al., 2018; Orakcı, 2021; Sujarwo et al., 2024). Learner autonomy emerges from learner-centered methodologies and aligns with their foundational principles; it is an implicit objective in education aimed at cultivating individuals capable of establishing personal goals and engaging in lifelong learning (Koç & Koç, 2016).

2.3. Metacognitive

The metacognitive concept increasingly acknowledged in educational psychology and related disciplines primarily pertains to the comprehension, regulation, and awareness of one's cognitive processes (Thongsomnuek et al., 2024). The building up of metacognitive knowledge involves several tactics, such as self-questioning, verbalizing thoughts during task execution, and constructing visual representations (Wu, 2014). Metacognitive awareness arises from metacognitive experiences and can facilitate the development of metacognitive knowledge and achievement (Nosratinia & Zaker, 2014; Teng & Yue, 2023). Metacognitive skills help learners become aware of their thinking and learning talents and weaknesses, allowing them to establish objectives, monitor their progress, and assess their success (Tsamago & Bayaga, 2024).

2.4. Digital literacy (DL)

Digital literacy was intrinsically connected to education. The author underscored the Internet's revolutionary potential and characterized digitally literate individuals as adept at managing online text and multimedia in formal educational contexts. Nevertheless, its exact meaning remains ambiguous, mainly due to its relatively recent inception. Before the extensive utilization of platforms such as Google, Facebook, and YouTube, initial endeavors to comprehend digital literacy practices were undertaken, concentrating on competencies including online research, social networking, and e-learning—activities that have since been essential to everyday life (El Messaoudi, 2024). Digital literacy enables contemporary youth to obtain information and influence public opinion in decentralized ways (Syamsuri & Bancong, 2022). Those with higher digital literacy possess advanced skills to evaluate information critically, distinguishing between credible sources and misinformation (Siriwattanarat et al., 2024). Digital literacy thus serves not only as a tool for individual development but also as a crucial asset for civic engagement and social advancement in our increasingly digital world (Mohammadi et al., 2020; Siriwattanarat et al., 2024). The overarching goal of digital literacy is to empower individuals with the skills to use information and communication technologies (ICT)

effectively and insightfully, facilitating active and informed participation in a knowledge-based society (Siddiq & Scherer, 2019).

The contribution of study with Higher-order thinking skills (HOTS), metacognition, and digital literacy are investigated concerning learner autonomy at Indonesian private institutions. While earlier studies have looked at these elements separately, this study assesses their combined impact on digital autonomous learning. By addressing challenges like the digital divide and metacognitive strategies, the results assist create instructional strategies that enhance students' self-regulation and critical thinking. The study also offers empirical data for legislators and teachers to design curricula and digital literacy campaigns supporting learner autonomy and arming students with the cognitive and technological tools they require to succeed in a digital and knowledge-driven society.

Research Questions

- 1) What is the effect of Digital Literacy on HOTS?
- 2) What is the effect of Digital Literacy on Metacognitive?
- 3) What is the effect of Metacognitive on Learners' Autonomy?
- 4) What is the effect of HOTS on Learners' Autonomy?
- 5) How does Digital Literacy affect Learners' Autonomy through Metacognitive?
- 6) How does Digital Literacy affect Learners' Autonomy through HOTS?

Hypothesis

- 1) There is an effect of Digital Literacy on HOTS
- 2) There is an effect of Digital Literacy on Metacognitive
- 3) There is an effect of Metacognitive on Learners' Autonomy
- 4) There is an effect of HOTS on Learners' Autonomy
- 5) There is an effect of Digital Literacy on Learners' Autonomy through Metacognitive
- 6) There is an effect of Digital Literacy on Learners' Autonomy through HOTS

This study aims to investigate the impact of learners' autonomy on HOTS, metacognitive, and digital literacy in Indonesian students. It will offer insights and pragmatic recommendations to improve educational quality and outcomes in Indonesian private universities.

Figure 1. Represents the research framework of this study. It focuses on exploring the effect of Digital Literacy on Learners' Autonomy through Metacognitive and HOTS

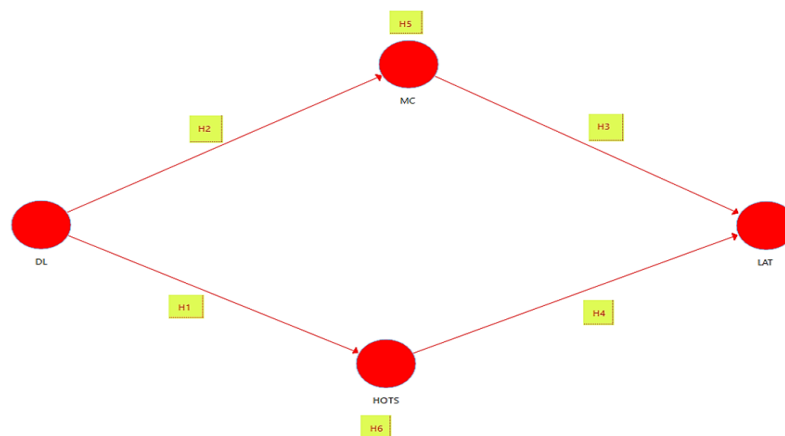


Figure 1. Conceptual Framework of the Research

3. Methodology

3.1. Research Design

This study investigates the effect of learners' autonomy on Indonesian students' higher-order thinking skills (HOTS), metacognitive, and digital literacy. To attain the objective, the present study employed survey research with a quantitative method by using Partial Least Squares Structural Equation Modelling (PLS-SEM) for data analysis.

This study applied a quantitative approach, with a total number of participants of 1.232 students in Indonesia (N=1.232). It employed cluster random sampling to select participants in Indonesian private universities. The following processes were used to establish the sample that would be the focus of the investigation. Participant demographic data by gender, age, and learning experience follows. Participant Demographic Data started 17–52-year-olds from the beginning of the first semester until the last semester in all private universities in Indonesia.

The researchers were responsible for determining the required sample size and randomly selecting respondents. An effective method to achieve this is disseminating survey invites through WhatsApp groups that specifically target the desired respondents. The process involves waiting until the responses reach the desired number of respondents. Researchers determined the number of groups by evenly including the same members in each group and ensuring that each group is different from the others. Next, they randomly selected clusters for sampling. Segmentation is based on geography for use in cluster sampling; this can be done by classifying sampling clusters through representatives of each group in the entire cluster.

Thirty-two assertions about learners' autonomy's influence on higher-order thinking skills (HOTS), metacognitive, and digital literacy in Indonesian students helped to create the questionnaires. The pedagogical competency of the teachers in terms of the skill aspect was assessed using the questionnaires; the questionnaire comprised (a) statements regarding behaviors, attitudes, and skills that reflect a student's ability to take control of their learning process, (b) statements about offer a comprehensive understanding of digital literacy focusing on skills in technology use, critical evaluation, responsible participation, and adaptability in the digital age, (c) statements about learner's ability to reflect on, understand, and control their learning processes, (d) statements about skills needed to engage in HOTS, fostering learners who are capable of independent, critical, and creative thought across various complex contexts. The measurement scale used in these questionnaires was the Likert scale.

3.2. Data collection and instrument

Data collection was obtained from respondents and analyze (Mills et al., 2019). The research instruments employed were web-based surveys that were completed directly by the participants. Closed questions allow respondents to deliver unpremeditated responses to inquiries, hence fostering possibilities and the possibility for more spontaneity. Thus, this will mitigate the bias that arises from the closing of the fully answered form. In contrast, the closed-ended questionnaire limits respondents from giving answers that depart from particular metrics or those explicitly defined by the researchers (Cohen et al., 2017). Concluding the terminated questionnaire provides a more convenient approach for researchers to carry out the coding process and successfully eliminates irrelevant responses, especially for specific topics.

On the other hand, closed-ended questions have some important problems, including the demand for extensive coding of lengthy responses and the increased likelihood of respondents not responding to the survey. When working with long online surveys, coding may provide challenges, because open-ended questionnaires often produce a wider range of responses than closed-ended questionnaires do. In addition, coding may present certain challenges. Employing closed-ended

questions will lead to a higher quantity of inadequate responses from survey participants. The distribution of students throughout the various regencies is taken into account when collecting sample data (Mulyana & Maylawati, 2024). Due to the large amount of data required, the data collection technique involved distributing online questionnaires to every school in Indonesia. As part of the process of collecting data, a supervising instructor kept an eye on the students as they filled out the questionnaire. This was done to guarantee that the data collected was accurate.

3.3. Data analysis

The main data for this study were gathered through the use of questionnaires. The questionnaire items were conducted to obtain the validity of the items that comprised the construct of the research (construct validity) (Rosmayanti et al., 2022). A robust statistical method known as PLS-SEM was utilized to analyze the data that was acquired through the use of questionnaires. This method sought to investigate the connections that exist between the variables that were observed and the constructs that underlie them. PLS-SEM is particularly useful for estimating cause-effect models that are based on theoretical frameworks. As a result, it is ideally suited for complicated models that incorporate numerous constructs and the interrelationships between them.

Partial Least Squares Structural Equation Modeling (PLS-SEM) with its capacity to manage measurement errors, evaluate latent constructions, and provide high predictive accuracy. PLS-SEM is a potent analytical method extensively applied in social sciences research. PLS-SEM is very successful when handling complicated models, small sample sizes, and non-normal data distributions, unlike covariance-based SEM. Often used in exploratory and theory-building studies with an eye on maximizing explained variance in dependent variables, PLS-SEM lets researchers confirm theoretical frameworks, examine causal linkages, and create strong predictive insights by combining structural models with measurement. Its applicability covers several fields, including psychology, business, and education, so it is a necessary instrument for understanding complex relationships between observed and unobserved variables. By employing PLS-SEM, this analysis ensures a comprehensive examination of the hypothesized relationships, allowing for a nuanced understanding of how variables like digital literacy, metacognitive skills, and higher-order thinking contribute to learner autonomy (Sharma et al., 2019; Zeng et al., 2021).

The current study utilized the growing prevalence of secondary data analysis, namely survey data, to redirect the research emphasis from mere verification to developing predictive and causal-predictive models. This research context is highly appropriate for a prediction-oriented PLS-SEM approach (Hair et al., 2019). Two elements define the PLS-SEM analysis of this work: the measurement model (outer model) and the structural model (inner model). Whereas the measurement model shows the interactions between the constructions and the indicator variables, the structural model defines the links among the constructions. The study of data starts with assessing the validity and dependability of the tool. Then, it moves on with the conventional assumption test required for regression analysis. Four test forms abound in this phase: the linearity test, the heteroscedasticity test, the multicollinearity test, and the normalcy test. The third phase consists of simultaneous F-test hypothesis testing and multiple linear regression analysis (Collier, 2020).

3.4. The Procedure for Collecting Data

This research procedure involves three primary stages. The first stage is the preparation phase, where researchers identify issues or phenomena in the field. They undertake a literature study during this step, employing a variety of sources, such as books and academic journals, among other forms of information. In addition, the researchers formally apply to the leadership of the institution where the research will take place to request permission to carry out the study. At this point, they also develop research instruments, specifically preparing questionnaires.

The second stage is the data collection phase. Researchers administer questionnaires to participants, who initially fill out informed consent papers to demonstrate their willingness to participate. Before the distribution of the questionnaires, the researcher provides an explanation of the objective of the study as well as the anticipated benefits for the individuals who participate in it. This is done before the distribution of the questionnaires.

The researcher highlights how vital it is for participants to be honest because the questionnaire serves as a self-evaluation instrument. This is because the questionnaire is used to evaluate the participants. Due to limitations in time and funding, the researchers employed a one-time experimental method, gathering data without prior formal validation of instruments. The third stage involves data analysis, wherein the acquired data is subjected to testing through Structural Equation Modeling (SEM) utilizing Partial Least Squares (PLS) for examination.

4. Results

4.1. Description of Findings

The research examines the impact of students' autonomy of metacognitive skills, higher-order thinking skills (HOTS), and digital literacy among Indonesian students. The researchers employed SEM-PLS multivariate methodologies, encompassing exploratory and confirmatory factor analyses.

The description of the respondents based on gender

The participants in this study were only students from Indonesia. The participants in this study were chosen using a quota sampling method. The distribution of responders is illustrated in Table 1.

Table 1. Respondent characteristics based on gender

Gender	Number of Respondent	Percentage
Male	246	19.9%
Female	986	80.1%
Total	1.232	100%

According to Table 1, 19.9% of respondents were male and 80.1% female. The majority of questionnaire respondents were female students. This survey has 17–52-year-old respondents. The following table presents data on the respondents' characteristics by age.

Table 2. Respondent characteristics based on age

Age	Number of Respondents	Percentage
17-28 years old	518	42%
29-40 years old	628	51%
41-52 years old	86	7%
Total	1.232	100%

Table 3. Reliability and Validity Results

Construct	Items	Factor Loading	Cronbach's Alpha	Rho_A	Composite Reliability
LAT	LAT1	0.736	0.843	0.846	0.888
	LAT2	0.768			
	LAT3	0.805			
	LAT4	0.785			
	LAT5	0.822			
MC	MC1	0.754	0.825	0.827	0.877
	MC2	0.760			
	MC3	0.788			
	MC4	0.760			
	MC5	0.771			
HOTS	HOTS1	0.760	0.853	0.854	0.895
	HOTS2	0.820			
	HOTS3	0.775			
	HOTS4	0.813			
	HOTS5	0.798			
DL	DL1	0.758	0.846	0.847	0.890
	DL2	0.802			
	DL3	0.813			
	DL4	0.752			
	DL5	0.806			

Excellent validity and dependability abound on the scales for every construct (LAT, MC, HOTS, DL) in this model. The items for each construct show a good correlation with the desired construct based on the high factor loading values, therefore indicating that the items are suitable indicators to gauge the construct. Since all factor loading values are higher than 0.7, every component significantly helps to create a bigger build. Moreover, for every construct the Cronbach's Alpha and Rho_A values exceed the advised level of 0.7. This suggests high internal consistency among every construct's element. Therefore, every construct in this model is dependable since it reveals a great degree of homogeneity among the objects used in measurement. At last, with values over the advised minimal level, the Composite Reliability and Average Variance Extracted (AVE) figures also corroborate the same conclusions. While AVE of more than 0.5 implies that each construct can explain more than half of the variance of the items that assess it, high composite reliability ratings show that these constructions have remarkable internal consistency. With consistent and valid items assessing the target constructs, this measuring model can be regarded as generally good.

Table 4. Fornell-Larckler criterion

Constructs	DL	HOTS	LAT	MC
DL	0.787			
HOTS	0.671	0.794		
LAT	0.605	0.654	0.784	
MC	0.607	0.728	0.741	0.767

Note: LAT=Learners'Autonomy; MC=Metacognitive;HOTS=High Order Thinking Skill;DL=Digital Literacies

The model displays good discriminant validity based on the Fornell-Larcker criterion. Each build is unique and measures a different notion since the square roots of the AVE for every construction exceed the correlations between them.

Table 5. Heterotrait-monotrait ratio (HTMT)

Constructs	Digital Literacy	HOTS	LAT	MC
DL				
HOTS	0.787			
LAT	0.714	0.769		
MC	0.723	0.864	0.882	

Note: LAT=Learners'Autonomy; MC=Metacognitive;HOTS=High Order Thinking Skill;DL=Digital Literacies

The model demonstrates discriminant validity depending on the Fornell-Larcker criterion. Higher than their correlations with other constructs, the square roots of the AVE for every construct (DL, HOTS, LAT, and MC) demonstrate that the constructs are unique and measure different underlying concepts. Consequently, the ideas in this model are both accurate and legitimate.

Table 6. Path Coefficients

Hypothesis	Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Decision
H1	DL > HOTS	0.671	0.672	0.019***	35.951	0.000	Supported
H2	DL > MC	0.607	0.608	0.021***	28.285	0.000	Supported
H3	MC > LAT	0.564	0.565	0.030***	18.600	0.000	Supported
H4	HOTS > LAT	0.244	0.243	0.031***	7.860	0.000	Supported

Note: LAT=Learners'Autonomy, MC=Metacognitive, HOTS=High Order Thinking Skill, DL=Digital Literacies;***p< 0.001

Support for all four hypotheses—H1, H2, H3, and H4—is found. Digital literacy (DL), HOTS, metacognitive competency (MC), and learning achievement (LAT) have all statistically significant links, therefore suggesting that the model is rather well-supported by the data. The strong validity of the results is confirmed by the T values for all hypotheses being well above the threshold of 1.96 and the p-values being all less than 0.05.

Table 7. Specific Indirect effects

Hypothesis	Relationship	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values	Decision
H5	DL > MC > LAT	0.342	0.343	0.023	14.969	0.000	Supported
H6	DL > HOTS > LAT	0.164	0.164	0.022	7.575	0.000	Supported

Note: LAT=Learners'Autonomy, MC=Metacognitive, HOTS=High Order Thinking Skill, DL=Digital Literacies;*** $p < 0.001$

Two hypotheses—H5 and H6—are validated. The findings show that by means of both Metacognitive Competence and Higher Order Thinking Skills, Digital Literacy indirectly affects Learning Achievement. The statistically significant mediation effects for both paths emphasize the need of both Metacognitive Competence and HOTS in mediating the interaction between Digital Literacy and Learning Achievement.

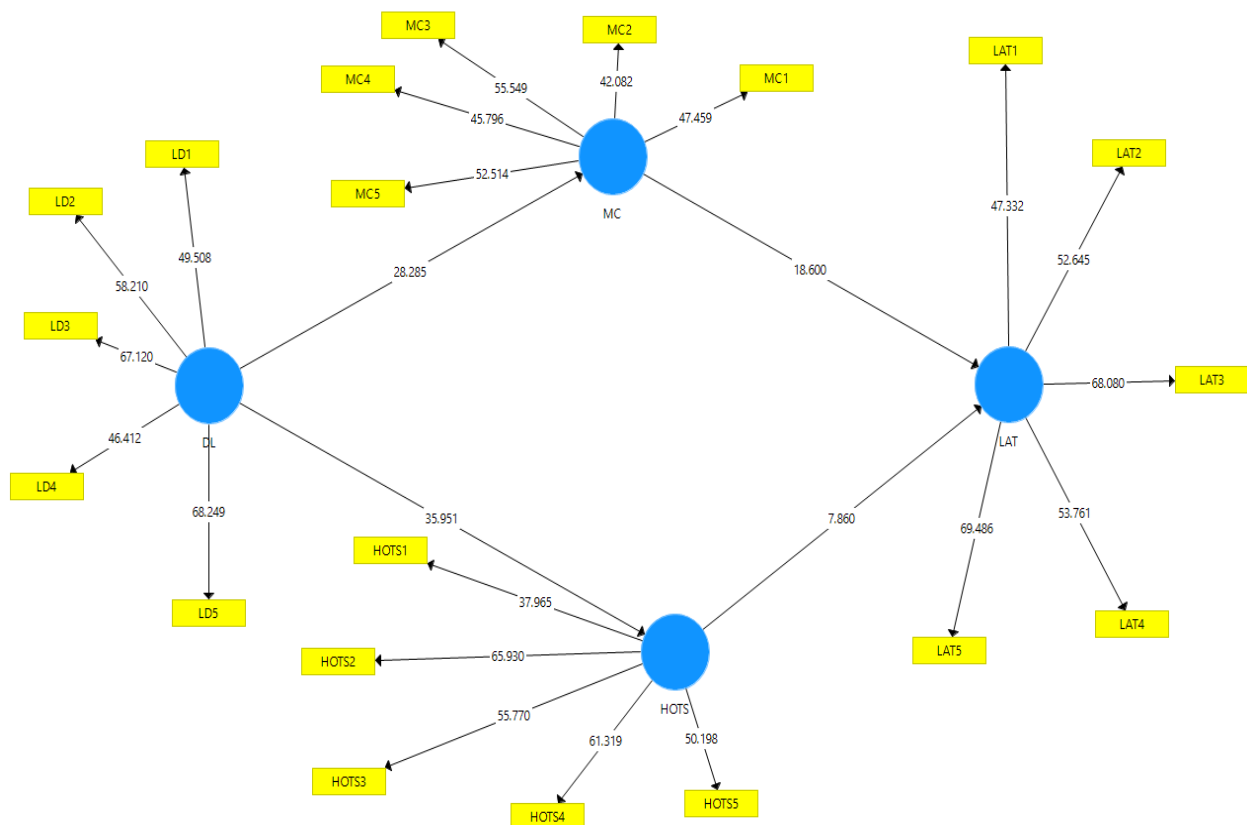


Figure 2. PLS Algorithm Results

5. Discussion

The results of this study are in accordance with the previous research on the effectiveness of using AI in teaching EFL writing while at the same time highlighting some of the limitations of the

Digital literacy helps students develop higher-order thinking skills (HOTS). Students with improved digital literacy can self-reflect and alter their learning processes, improving metacognition. Students with low digital literacy are disadvantaged. Higher-order thinking skills (HOST) moderately affect learners' autonomy, suggesting that critical and analytical thinkers are more willing to accept responsibility. Metacognitive skills boost learner autonomy. Therefore, students with strong self-regulation skills are more likely to manage and steer their learning.

5.1. The effect of digital literacy on HOTS

It has been demonstrated that higher-order thinking skills (HOTS) are positively impacted by digital literacy in a statistically meaningful way. As a result of the substantial and statistically significant beneficial effect that digital literacy has on higher-order thinking abilities (HOTS), it has been found that students who have advanced digital literacy are better able to perform challenging cognitive activities such as analysis, assessment, and invention (Mukhlis et al., 2023). Students are better able to apply these competencies in problem-solving, critical thinking, and advanced reasoning as they improve their digital skills, such as operating digital tools, critically analyzing information, and using online resources. This link implies that students are more equipped to employ these competencies as they improve their digital skills (Xiangjun & Singh, 2024).

Digital literacy (DL) helps students recognize, assess, and use online information (Kong, 2014). Critical thinking and analysis are needed for higher-order thinking (HOTS). Students with good digital literacy can evaluate sources, identify biases, and form coherent arguments. Digital literacy gives students the ability to analyze material critically, find solutions to problems, and come up with imaginative solutions, all of which contribute to an improvement in higher-order thinking (Setyarini et al., 2024).

5.2. The Effect of Digital Literacy on Metacognitive

Students who have a higher level of digital literacy can self-reflect and effectively regulate their learning processes, which is a significant contribution to the development of metacognitive skills. Students who have a higher level of digital literacy have improved capacities for self-reflection and self-regulation in their learning pursuits (Alavi et al., 2016). This shows that digital literacy plays a crucial role in the development of metacognitive skills. When students improve their skills with digital tools, such as retrieving, organizing, and critically evaluating digital material, they simultaneously improve their capacity to effectively monitor and alter their learning practices (Nosratinia & Zaker, 2014). This association shows that students who improve their proficiency with digital tools learn more effectively. Students who are proficient in digital literacy can employ online resources to initiate the process of establishing targets, monitoring their progress, and evaluating their results. The statistically significant link is that the talents associated with digital literacy are technical and improve essential cognitive processes (Pinski et al., 2024).

Furthermore, the impacts of digital literacy are neither automatic nor generally applicable, although it is a crucial catalyst for improving metacognitive skills. The use of deliberate instructional techniques is required of educators to maximize the potential of digital resources and ensure that everyone has equal access to them. The importance of digital literacy in fostering self-reflection and self-regulation in the educational setting will be increased if barriers such as cognitive overload and the digital gap are reduced.

5.3. The Effect of HOST on Learners' Autonomy

Students who have superior critical and analytical abilities are more likely to take responsibility for their learning, which indicates that higher-order thinking skills (HOST) have a moderate influence on the autonomy of learners. Students who exhibit strong critical and analytical abilities are more inclined to take responsibility for their education, according to the findings of a study that found that higher-order thinking skills (HOTS) had a moderate impact on learner autonomy. This association suggests that as students participate in higher-order cognitive processes such as information analysis, viewpoint evaluation, and idea generation, they are more inclined to regulate their learning objectives, independently seek resources, and adjust their techniques as necessary (Yuriza et al., 2018).

The intermediate strength of this impact suggests that although higher-order thinking Skills (HOTS) contribute to autonomy, other factors may also significantly influence independent learning (Susiati et al., 2018). Suryawati et al., (2018) state that these qualities contribute to an increase in learners' capacity to engage in self-directed learning by enabling them to make judgments on the study methods that they utilize that are both informed and deliberate. Important research highlights the need to include higher-order thinking skills in educational standards. These skills increase students' autonomy, which is crucial for the lifelong acquisition of knowledge and flexibility.

5.4. The Effect of Metacognitive on Autonomy

Students with good self-regulation skills are more likely to direct their learning in the classroom due to their metacognitive skills. Self-regulated students learn better with metacognition. By planning, monitoring, and assessing their understanding and growth, students can take more responsibility for their education. This is seen in how metacognitive skills affect autonomy. Metacognitive skills let students set goals, evaluate their progress, and adapt their techniques, encouraging proactive and self-directed learning.

This study shows that metacognitive skills help students become self-directed learners who can succeed in a variety of learning environments, both inside and outside the classroom. Learners who evaluate their comprehension and modify their techniques acquire the confidence and competence to navigate their educational path, fostering more independence (Yatani et al., 2024). These skills enable learners to assess intricate information, make educated judgments, and engage in independent problem-solving—attributes that foster autonomous learning. Since digital tools and resources are essential to contemporary education, digital literacy empowers students to access, assess, and employ online knowledge proficiently (Nurhikmah et al., 2024). Autonomous learning requires literacy because it allows students to seek varied resources and evaluate trustworthy material without teacher guidance. Curriculums that include these competencies create more autonomous and flexible students who are prepared for lifelong learning in a digital and information-dense world.

Some previous studies supported this study, which found that learner autonomy through digital literacy and negotiated learning has significant benefits in enhancing student engagement, metacognitive awareness, problem-solving skills, and readiness for lifelong learning (Ting, 2015). Successful implementation requires attention to digital literacy support, teacher preparation, and balancing instructional guidance with student autonomy (Thongsomnuek et al., 2024). This is increasingly significant for learner autonomy (Dang, 2012). Autonomous learning in digital English classrooms in higher education has numerous benefits, including improved language proficiency, critical thinking, digital literacy, and self-regulation skills (Pratiwi & Waluyo, 2023).

This study emphasizes the distinct educational environment of Indonesian private colleges, in contrast to most studies undertaken in other environments. As a result, the findings are more significant and useful for Indonesian educators, administrators, and policymakers.

The contextual emphasis on Indonesia, the interdisciplinary incorporation of autonomy-enhancing competencies, and the implications of this research for educational practices, curriculum creation, and preparation in the digital era are the three factors that contribute to the novelty of this research. Because of the significant influence that digital literacy has on the autonomy of learners, educational programs must emphasize the development of digital capabilities. Institutions can give students the autonomy and assurance required to excel as independent, self-directed learners in academic and professional settings (Littlewood, 1996).

Practical Implication of the Study

A holistic education that integrates digital literacy, higher-order thinking skills (HOTS), and the development of metacognitive skills is required since practical applications demonstrate the requirement of such an education. Through the implementation of this technique, the curriculum, instructional methods, and institutional norms will be able to incorporate these essential competencies comprehensively. When digital literacy is emphasized, students are taught how to use digital tools and information. Higher-order thinking skills foster improvements in critical thinking, problem-solving, and innovative thinking. Student reflection on their learning, goal-setting, and the development of methods for academic and personal development are all facilitated by metacognition (Shlianachak et al., 2024). This integration equips students for continuous learning, allowing them to adjust to swiftly evolving knowledge environments and technology progressions (Kong, 2014).

6. Conclusion

Findings emphasize that digital literacy helps students learn higher-order thinking skills. Digital media literacy helps students to improve their learning and participate in self-reflection. Metacognition—that is, the ability to recognize and control one's thinking and learning processes—is much enhanced by this talent. Strong technological knowledge helps students to fit several learning environments, thereby enhancing their whole educational experience. However, low-digital literacy students will experience various learning challenges. They may have trouble obtaining information, communicating, or using digital tools for learning. This may restrict their metacognitive abilities and higher-order cognitive talents. Consequently, students must enhance their digital literacy to remain competitive in this progressively digital landscape. Higher-order thinking skills (HOTS) influence student autonomy. Students possessing critical and analytical thinking skills exhibit greater self-direction. They can take initiative, make decisions, and efficiently schedule their time. Students' learning autonomy is improved by metacognitive abilities, including plan modification and self-monitoring. Advanced self-regulating students may more successfully control and direct their learning, which improves their academic performance.

7. Limitation

The results highlight the critical need for digital literacy in developing higher-order thinking skills (HOTS) and metacognitive capacities, thereby supporting students' learning autonomy. Limitations do remain, though, especially for inadequate digital literacy students who might find it difficult to acquire information, communicate clearly, and apply digital tools for learning. These difficulties can impede their capacity for independent learning, critical thinking, and self-reflection.

8. Suggestion

Further researchers should conduct comparative analyses among various universities (e.g., public versus private, urban versus rural) in Indonesia to ascertain whether the influence of these skills on learner autonomy differs by institutional setting. The study uses a larger sample. The results may not apply to all private university students nationwide. Diversities in socioeconomic, cultural, or educational backgrounds can affect autonomy and digital literacy levels, which may not be entirely represented in restricted respondents.

Declarations

Author Contributions. Abdul Wahid.: Literature review, conceptualization. Nur Afni: methodology, data analysis. Sujarwo: review-editing and writing, original manuscript preparation.

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