

STUDENTS' PERCEPTIONS OF ARTIFICIAL INTELLIGENCE UTILIZATION IN ONLINE SELF-REGULATED WRITING ACTIVITIES TO ENHANCE LEARNING AUTONOMY

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ABSTRACT

The study investigates students' perceptions on the use of artificial intelligence (AI) in online Self-Regulated Writing Activities (SRWA) and the factors that influence students' practices of online SRWA in promoting their autonomy. The mixed-methods research design of this study incorporated quantitative surveys of 78 students learning English as a foreign or second language and qualitative interviews with six selected students using purposive sampling. The collected data from the questionnaires and semistructured interviews were analyzed using descriptive statistics and thematic analysis. The findings reveal that the students showed positive perceptions of using AI in online SRWA to enhance their autonomy, which was affected by three factors: learning mode, ecological dimension, and individual aspect. Students are motivated to continue developing time management skills and maintaining a community of learning to enhance AI effectiveness in online self-regulation learning framework and support their autonomy. The research further addressed the implications for online writing activities and made recommendations for future research.

Keywords: *artificial intelligence, autonomy, online writing, self-regulated learning*

INTRODUCTION

Student writing ability is fundamental for transforming ideas and conveying clear communication in academic settings (Wale & Bogale, 2021; Yu & Liu, 2021). By mastering this skill, students promote their creativity, critical thinking, and problem-solving to accomplish tasks during classroom activities (Liang & Fung, 2021). However, writing is a challenging and complex academic skill used to meet the demands of academic purposes (Han & Hiver, 2018; Supiani et al., 2023; Teng & Zhang, 2016). Previous research states that several obstacles are found in a writing

class, including instructional attention, lack of practice opportunities, and few learning resources (Golparvar & Khafi, 2021; Wen & Walters, 2022). Other challenges encountered by students are linguistics capacity and prominent cultural differences, which also lead to their unwillingness to participate in writing classes (Aizawa et al., 2023; Ratnawati et al., 2023). This finding is corroborated by Ma (2021), who reported that students with sociocultural challenges struggled with their writing assignments.

An instructional strategy to handle these obstacles is self-regulated writing activities (SRWA),

which is focused on student autonomy (Palermo & Thomson, 2018). Previous research findings report the effectiveness of SRWA in increasing students' writing skills by fostering autonomy, setting objectives, and promoting reflective practices (Bagettun & Wasson, 2006; Cahyono et al., 2024; Zimmerman, 2013). Practically speaking, SRWA enables students to organize, track, and assess the process, and to enhance writing quality and academic achievement (Zimmerman & Moylan, 2009). Similarly, Guo et al. (2021) stated that students who attend in-classroom practices of SRWA produce more coherent and structured compositions because SRWA maintains motivation and self-efficacy during writing process. Umamah and Cahyono (2022) reported that self-regulation techniques impressively enhanced writing appropriateness and fluency for middle- and high-school students.

SRWA successfully fosters writing autonomy by motivating and prompting students to be responsible for their own learning. Through standard components of SRWA, including objective-setting, self-monitoring, and assessment, students promote their self-persistence and learning accountability (Zimmerman, 2013). For example, self-regulated writing activities urge students to adopt strategies associated with time management, goal-setting, and reflection skills, and they are motivated to accomplish demanding assignments (Umamah et al., 2022). Students also become more efficacious and prominent decision-makers concerning the writing process (Teng, 2022b).

Regardless of the effectiveness for improving writing performance and autonomy, integrating artificial intelligence (AI) into self-regulated activities shows a noticeable gap between online and conventional settings. Past findings reveal that AI-powered resources helped students generate ideas, motivated their creativity, and produced real-time feedback, but there was little knowledge regarding the incorporation of AI technologies into the online setting found in the students' perceptions of the conventional setting. According to Zhou and Hiver (2022), most previous research focused on student roles in face-to-face SRWA, outlining how these instructional methods enabled them to set academic targets and observe and evaluate personal progress and work. The transition to the online mode had revealed the need for

examining self-regulated learning and considering digital technologies ability to provide flexibility and address the learning needs of 21st-century students (Muslimin et al., 2024; Shortt et al., 2023).

The present research focuses on how students view AI usage in online SRWA to promote learning autonomy. It also investigates the contributing factors associated with the implementation of online SRWA. This research provides students' views of how the online mode accommodates self-regulation learning skills. It further examines students' perspectives of online exercises to ascertain if the adopted strategy enhances their autonomy, confidence, and writing skills. It also seeks insight into how online SRWA are perceived, how teachers optimize AI technologies, and ways to promote self-directed learning in contemporary classrooms. We asked the following two questions:

1. How do students use AI in online SRWA to enhance autonomy?
2. What are contributing factors of using AI tools in online SRWA to enhance autonomy?

LITERATURE REVIEW

Self-Regulated Learning in a Writing Context

SRWA refers to the explicit writing instructions, self-regulated strategies, and procedural designs that are concurrently learned systematically during the writing process (Nückles et al., 2020) to nurture effective, goal-directed efforts and foster enjoyable environments for optimally accomplishing students' writings (Teng & Zhang, 2016). SRWA has gained considerable attention in writing-education research on English as a foreign language and English as a second language contexts (Collins et al., 2021; MacArthur et al., 2015; Nückles et al., 2020; Rahimi & Fathi, 2021). Collins et al. (2021) highlighted potential ways for integrating writing and reading instruction and supporting SRWA implementation in general education classrooms. Moreover, facilitating effective training of SRWA for teachers can help students learn about the writing process, improve self-control techniques, develop progress evaluation, and increase writing output (MacArthur et al., 2015).

In addition, multidimensional aspects of SRWA include cognitive, metacognitive, sociobehavioral, and motivational regulation, which are impacted by SRWA implementation (Teng et al., 2022).

According to Thompson and Childers (2021), students actively apply their self-regulation skills to achieve their academic goals. In regard to the multidimensional aspects, students need cognitive support to organize their ideas and activate prior knowledge (Garcia & Pintrich, 2023; Ohst et al., 2014; Pintrich & Schragben, 2012). By implementing the SRWA framework, students are encouraged to apply their prior knowledge, review the materials being learned, and organize their ideas and prepare them for the drafting stage.

In terms of metacognitive regulation, students gain direction in setting goals, monitoring their writing development, and reflecting on feedback during the drafting and revision stages (Zimmerman & Schunk, 2011). According to Nielsen (2014), students who engage in this metacognitive activity are more likely to be aware of their strengths and growth and will produce better drafts and have a deeper comprehension of the writing process. In addition, sociobehavioral regulation addresses peer review, group discussions, and cooperative writing assignments that promote social interaction and handling feedback (Segundo Marcos et al., 2020). This strategy helps students learn from one another and regulate their behavior within group dynamics, contributing to better teamwork and shared responsibility during

the writing process (Klasmeier & Rowold, 2022). Finally, the framework also supports motivational regulation that cultivates students' intrinsic motivation at each stage of the writing process by implementing strategies like setting goals, providing positive feedback, and allowing students autonomy (Harris, 2023), as shown in Figure 1.

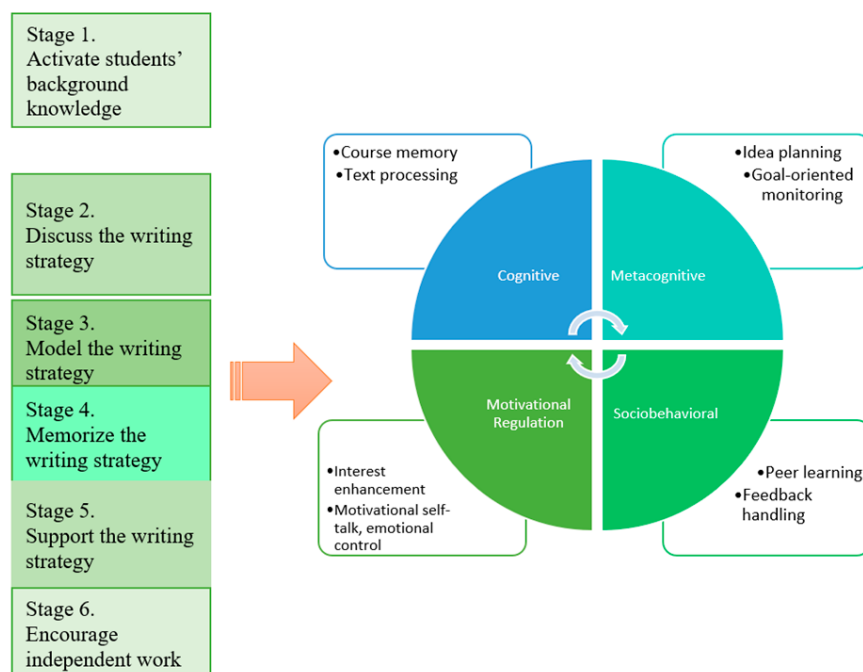
Figure 1 shows that implementing self-regulated activities in writing class assists students in gaining the core abilities of self-regulation skills for enhancing writing quality and autonomous learning (Harris & Graham, 2017; Schunk & Zimmerman, 2007). According to Graham and Harris (2018), these activities guide students in organizing writing assignments by encouraging them to plan, draft, and revise their work. Students also develop more resilient mechanisms to overcome obstacles and manage their writing challenges by employing these strategies (Efklides, 2011).

Self-Regulated Learning and Writing Activities

Self-regulation learning (SRL) encourages students to set personal goals, monitor their progress, and adjust strategies as needed, which are essential in developing a sense of autonomy in writing (Challob, 2021). Through the framework, students independently navigate the writing process from

Figure 1.

Multidimensional Aspects of Self-Regulated Writing Activities



planning and drafting to revising and finalizing their writing (Teng, 2022a). By practicing SRL, students control their writing skills, which empowers them to manage complex writing tasks without relying heavily on external guidance (Liu et al., 2023).

Additionally, research indicates that the implementation of SRWA encourages a shift from teacher-centered to student-centered learning, which promotes students' autonomy and develops self-regulated writers (Admiraal et al., 2024; Cai & Lombaerts, 2024). According to Graham and Harris (2018), students who work in an SRL framework actively set personal goals and use self-assessment strategies, which instills a sense of responsibility and control over their learning. Students who engage in self-regulated writing tend to become more reflective and proactive, less reliant on immediate feedback, and more capable of self-evaluating their work (Mason et al., 2023).

Moreover, SRWA cultivate students' metacognition for nurturing autonomous learning. As Azevedo's (2020) study showed, metacognition urges students to think critically about their writing process and to develop strategies for planning, organizing, and revising their work autonomously. Another study also revealed that students sustained their autonomy through practicing self-regulated learning, which fosters their persistence and resilience during the writing process (Zimmerman & Schunk, 2011). Since it is the current learning situation, the digital environment needs to accommodate students' learning opportunities and provide them with even greater autonomy (Černochová & Selcuk, 2020). A study by Engeness (2021) shows that digital writing platforms facilitate independence by allowing students to manage their progress, seek peer feedback, and make adjustments based on reflective feedback. Further, digital interaction empowers students to take charge of their learning and develop self-directed strategies that are beneficial beyond the classroom and developing autonomous skills.

Student's Role in AI Utilization of Online Self-Regulated Writing Activities

The students' role in implementing the SRWA framework is to become active students during the teaching and learning process (Chung et al., 2021). Brady (2021) highlighted that self-regulated learning requires students to actively engage in

forethought, performance, and self-reflection, where they take ownership of planning, executing, and reviewing their writing tasks. This learning process also fosters a student-centered approach in which students are empowered to make decisions, monitor their progress, and adjust their strategies accordingly (Kong & Wang, 2021). From this viewpoint, students are not merely passive receptors of instruction but active participants who initiate, regulate, and reflect on their writing processes.

Today's need for learning cannot be separated from the massive use of artificial intelligence (AI) in academic settings in which students' roles are becoming more urgent than the previous ones. Students must be critical decision-makers regarding AI assistance during writing (Salvagno et al., 2023). To perform this role, they need skills, including the ability to set realistic academic goals, evaluate sources, organize information, and revise their work based on both self-assessment and external feedback. According to Beiki et al. (2020), making decisions in writing requires critical thinking, language capability, and self-regulation skills. For example, in prewriting, students use AI to grasp ideas and brainstorm for writing outlines. In the whole process, AI tools are used to create essays concerning the prompts input by students. In the last stage, AI assesses the students' writing structure, coherence, and accuracy. By equipping students with self-regulated strategies, they can academically take over and responsibly decide how to use AI (Gayed et al., 2022; Lee et al., 2024).

METHODOLOGY

Research Design

The mixed-methods research design proposed by Plano Clark and Creswell (2008) was conducted in the study, integrating quantitative and qualitative approaches to investigate how students implement AI tools in online self-regulated writing activities to enhance their learning autonomy and to explore the factors influencing the practices of AI use in the framework of self-regulated learning in writing settings. First, quantitative surveys were administered to students actively engaged in online self-regulated writing activities in classroom practices. The surveys assessed how students use AI tools (e.g., Grammarly, Gemini AI, and ChatGPT) to support various stages of the writing process, including planning, drafting, revising, and self-assessment before publishing.

Following the survey, semistructured interviews were virtually organized with a purposive sampling of participants to gain deeper insights into the factors influencing the practices of AI utilization in self-regulated writing activities. These interviews aimed to capture the participants' perspectives on their cognitive, metacognitive, sociobehavioral, and motivational regulation domains for using AI tools for self-regulation in writing. The obtained qualitative data also allowed for exploring themes such as learning mode and ecological and individual support factors (e.g., motivation, growth mindset) that influence students' experiences with AI-assisted self-regulation learning in writing classes.

Research Setting and Participants

The participants comprised 78 students across Indonesia who actively used AI tools in online SRWA. These students were selected based on their engagement with AI-driven platforms and applications such as grammar checkers, content generators, and personalized feedback tools in the writing processes. The research captured multiple experiences and perspectives on AI use across many different academic environments by sampling students from various universities, as shown in Table 1. In addition to the questionnaire, semistructured interviews were conducted to six selected students with purposive sampling indicating low, intermediate, and high writing proficiency of the students.

Table 1.

Participants Data in the Questionnaire

Category	Classification	N	%
Gender	Male	16	20
	Female	62	80
Age	18–20	37	48
	21–23	36	46
	24–26	5	6
Years of Learning English	5–10	28	36
	10–15	43	55
	15–20	7	9
HE Institution	University	59	76
	Polytechnic	19	24
The Effort of English Writing	Yes	74	95
	No	4	5
Background Knowledge of Self-Regulation Learning in Writing Activities	Yes	73	94
	No	5	6

Data Collection Procedures

We administered a Likert-scale survey and conducted semistructured interviews to investigate students' insights into their experiences and perspectives on using AI in self-regulated writing activities. The survey consisted of 40 questions divided into two main sections. The first section (five questions) gathered students' personal information and background on their experiences learning English writing. The second section was the WSSRLQ (Writing Strategies for Self-Regulated Learning Questionnaire), which was adapted from Teng and Zhang (2016) and Wu (2015). This self-responder questionnaire comprised four domains, as indicated in the following table.

Table 2.

Four Domain Constructs of Questionnaires

Domains	Number of questions (N)
Cognitive	9
Metacognitive	9
Sociobehavioral	7
Motivational Regulation	10

The questionnaire covered cognitive aspects (nine questions) that explored the students' perspectives on course memory and text processing in their writing tasks. The metacognitive dimension contained nine questions, including the students' approaches to idea planning, setting goals, monitoring, and evaluating during the writing process. The sociobehavioral aspect, particularly peer learning and feedback handling, comprised seven questions. Finally, the motivational regulation aspect consisted of 10 questions, such as strategies for interest enhancement, motivational self-talk, and emotional control, to capture how students manage their motivation throughout the writing process. Before administering the survey, a reliability test was conducted through a pilot study for 30 students across Indonesian universities through Google Forms, and the collected data of questionnaire items were then analyzed using Excel. The analysis showed that Cronbach's alpha value was 0.81, meaning a high level of reliability.

The interview protocol consisted of six main questions to explore further key themes related to the practices of AI tools in students' online self-regulated writing. The interviews provided

in-depth qualitative data and captured the factors influencing students' use of AI tools, challenges they faced, and perceived impacts on their learning autonomy and writing skills as indicated in Table 3. This mixed data collection method offered a robust foundation for understanding the quantitative trends and qualitative nuances of AI utilization in self-regulated writing activities in the online learning mode.

Table 3.

Questions Construct of Semistructured Interviews

Construct	Questions samples	Main Questions Number
Practices of AI tools	How do you use AI tools in your writing?	1
Factors influencing AI use (cognitive aspect)	How do you use AI tools in the drafting stage in online SRWA?	1
Factors influencing AI use (metacognitive aspect)	How do you use AI tools to check your writing?	1
Factors influencing AI use (sociobehavioral aspect)	How do you use AI tools to discuss your writing with your mates in online SRWA?	1
Factors influencing AI use (motivational regulation aspect)	How you use AI tools to enhance your interest in writing?	1
Impact of AI use in learning autonomy	How is your learning autonomy after using AI tools in online SRWA?	1

Data Analysis

The research combined quantitative and qualitative methods to fully comprehend how students use AI in online SRWA. For quantitative data, descriptive statistical measures were analyzed using SPSS 24 software. The responses to the survey were scored on a Likert scale with 1 denoting *never*, 2 *seldom*, 3 *sometimes*, 4 *often*, and 5 *always*. These descriptive statistics provided a broad picture of AI usage in cognitive, metacognitive, sociobehavioral, and motivational aspects, by evaluating central tendencies and response variability. For qualitative data, a systematic, four-step procedure comprising transcription, data

reduction, classification, and interpretation was used to analyze this phase. Interviews were transcribed to ensure the authenticity of the participant responses. Next, data were reduced on the intended themes before classifying the responses into thematic classes in line with the research objectives. Contextually, some themes were used to classify intended data into three multidimensional aspects (Teng et al., 2022): learning mode, ecological dimension, and individual support. The interpretation procedure aimed to examine and comprehend the implications of the student observations concerning the use of AI to implement self-regulated learning in the writing context. Data displays were arranged according to participant identifiers (S1, S2, S3, etc.) to ensure anonymity and clarity while enabling a systematic analysis of individual thematic responses throughout the sample.

RESULTS

Students' Perceptions of AI Utilization in Online Self-Regulated Writing Activities

The descriptive analysis showed a mean (*M*) and standard deviation (*SD*) of 135.35 and 33.20, with minimum and maximum scores of 58 and 175, respectively. These results implied that both student ratings and responses varied widely. The participants generally performed above the midpoint, as shows by the mean categorized in the top half of the score range. Individual scores varied greatly throughout the sample, as evidenced by the *SD* (33.20), representing a large distribution around the mean, as indicated in Table 4.

Table 4.

Statistical Analysis of Survey

	N	Minimum	Maximum	M	SD
Students	78	58	175	135.35	33.20
Valid N (listwise)	78				

The results of the Likert-scale questionnaire, completed by 78 students, revealed various responses, suggesting diverse participant opinions. Overall, students had a positive perception of AI use in online SRWA. There was also enough variability to outline the range of views found in the *SD*. The student use of AI in online SRWA is shown in Table 5.

Table 5.
Variable Description of Survey

Classification	Interval Value	N	%
Very High	$151.6 < X \leq 175$	16	20.6
High	$127.2 < X \leq 150.6$	42	53.8
Medium	$102.8 < X \leq 126.2$	17	21.8
Low	$78.4 < X \leq 101.8$	4	3.8
Very Low	$54 \leq X \leq 77.4$	—	—

According to the research findings, the use of AI in online SRWA varied. With scores ranging from 127.2 to 150.6, the majority of the students (53.8%) were categorized in the High group. This implied that more than half of the students relied heavily on AI technologies to assist with SRWA. Meanwhile, 20.6% fell into the Very High category ($151.6 < X < 175$), showing their use of AI in writing. These two groups (74.4%) showed a clear trend of students successfully integrating AI into daily learning activities.

A lesser percentage used AI at a moderate or limited level; for example, the Medium category ($102.8 < X < 126.2$) represented 21.8% of students, who showed moderate usage of AI tools. Very few used AI in classroom practices, as proven by the fact that relatively few (3.8%) fell into the Low

group ($78.4 < X < 101.8$), representing limited usage, while none of the students were in the Very Low range ($54 < X < 77.4$). Overall, the statistics suggest that majority of the students used AI to a considerable extent during writing, with a sizeable percentage using it at high or very high levels. This data shows that students had accepted and effectively integrated AI.

The data on how students perceive AI usage in online SRWA foster learning autonomy is as shown in Table 6. This shows that a majority of them agreed that the use of digital tools promoted learning autonomy.

The Table 6 provides insights into student perceptions of using AI across four major domains, namely cognitive, metacognitive, sociobehavioral, and motivational regulation. The average scores in the cognitive domain for text processing ($M = 3.67$) and course memory ($M = 3.76$) indicated that students applied AI but with more variability. For instance, students reported always 12% and 13% in course memory and text processing, respectively. Despite the favorable opinions, students might consider AI to be marginally less relevant for direct cognitive support than other fields, implying they are convinced of their capacity.

The metacognitive domain had a crucial role in students' use of AI for online self-regulated writing activities, particularly in idea planning ($M = 3.96$) and goal-oriented monitoring ($M = 3.96$). In

Table 6.
The Utilization of AI in Online Self-Regulated Writing Activities

Domain	Items	Never (%)	Seldom (%)	Sometimes (%)	Often (%)	Always (%)	M
Cognitive	Course memory	1%	3%	14%	15%	12%	3.76
	Text processing	2%	3%	19%	18%	13%	3.67
Metacognitive	Idea planning	0%	4%	12%	15%	18%	3.96
	Goal-oriented monitoring	1%	3%	12%	16%	19%	3.96
Sociobehavioral	Peer learning	2%	4%	8%	25%	13%	3.83
	Feedback handling	1%	3%	7%	24%	13%	3.94
Motivational Regulation	Interest enhancement	1%	1%	4%	13%	16%	4.20
	Motivational self-talk	0%	0%	3%	13%	15%	4.21
	Emotion control	0%	2%	4%	13%	15%	4.26

the idea planning phase, 33% of students said they frequently used AI in this stage, compared to 4% who said they seldom did so. This implies that AI tools assist students in efficiently organizing their writing processes. Likewise, **goal-oriented monitoring with 35% of students frequently engaging in it** implies that AI-driven feedback systems, writing trackers, and revision assistants play a significant role in helping students assess and refine their writing.

The sociobehavioral domain was indicated by active student engagement in peer learning ($M = 3.83$) and feedback handling ($M = 3.94$) when AI is utilized in online self-regulated writing activities. Over a third (38%) of students said they frequently participated in peer learning, when ideas were shared and cooperation took place, compared to 6% who said they rarely or never did. This implied that meaningful connections were being facilitated by AI-powered joint authoring platforms and discussion boards. Similarly, 37% of students regularly engaged in feedback handling, which was enabled by AI-driven tools like automated grammar checkers and revision suggestions that improve writing and collaborative learning.

Students had the most favorable perception in the motivational regulation domain, with interest enhancement ($M = 4.20$), motivational self-talk ($M = 4.21$), and emotion control ($M = 4.26$) when using AI for online self-regulated writing activities interest enhancement was used by 29% of students frequently or always, whereas only 2% said they used it infrequently or never. In motivational self-talk, 28% of students utilized AI often and 0% never. Additionally, 28% of students actively regulated their emotions, demonstrating effective emotion regulation management. This finding shows that AI tools were crucial for inspiring and engaging students.

Factors Contributing to the Student Role in AI Utilization in Online SRWA

The qualitative data proves that the use of AI in online SRWA is influenced by a combination of learning modes, ecological aspects, and individual factors, as shown in Table 7. The learning mode focused on whether the learning was synchronous or asynchronous, because this influences the incorporation of AI tools having distinct opportunities and obstacles. Ecological factors are associated with student views concerning access to and attitudes

regarding the use of AI, including aspects of the larger educational environment, namely teacher support, school resources, and cultural perspectives on technology. Additionally, individual support constitutes self-regulation skills, motivation, and digital literacy on AI usage in an online framework.

Table 7 shows various factors influencing the successful implementation of AI usage across different domains. The cognitive aspect dealt with reliable internet access, language comprehension, and academic resources both within and outside the classroom. Technically speaking, to implement the interplay factors, teachers offer cognitive feedback, thereby motivating students to use digital platforms to self-review the content. Moreover, students were urged to memorize and be familiar with the platform complementing the framework, as represented in the following student interview script:

[S3] ...I benefitted from the academic support offered by learning platforms provided by the teacher. The platform enabled learning outside classroom activities and reviewing relevant areas required for the preparation of writing project work.

Table 7 shows that students were urged to use virtual tools to plan and monitor their own learning progress in the metacognitive domain. The platforms were flexible and easy to use and supported development. Students had the ability to manage their writing processes, self-reflection, time usage, and technical literacy, which enabled students to work independently toward the realization of academic objectives. They also complemented learning reflections that were connected to AI technologies, as depicted in the following interview script:

[S6] I enjoyed learning how to use this framework due to the adaptive and convenient atmosphere. My work could be assessed from anywhere without the limitless of time, face-to-face meetings, and resources. Since writing needs extra work and reviews to accomplish an expected result, I needed to plan, monitor, reflect, and even engaged in self-assessment aided by Grammarly.

In the sociobehavioral domain, the results proved that students were urged to communicate

Table 7.
Contributing Factors of AI Utilization in Online Self-Regulated Writing Activities

Theme	Subtheme	Interview Data
Cognitive	Learning mode	Student attendance and teacher socialization concerning effective learning, using the framework synchronously.
		Student participation in linguistic skills through MOOC professional development.
		Student familiarization with the platforms used.
	Ecological	Student condition on internet connection stability.
		Academic resources accessed by students both inside and outside class settings.
		Teacher support of cognitive feedback.
	Individual Support	Student comprehension of linguistic skill.
		Student capacity to memorize materials learned.
		Student self-review on material learned through platforms.
Metacognitive	Learning mode	Student planning of objective setting through provided platforms.
		Student monitoring the progress of virtual work.
		Student reflection on the writing was realized in online mode.
	Ecological	Adaptive and friendly use of virtual classroom environment.
		Learning platform used to ensure progress can be made any time and everywhere.
		Learning reflection associated with AI and technology use.
	Individual Support	Student technological literacy of platforms features was beneficial.
		Student time management to accomplish relevant steps in the writing process.
		Student self-regulation skill to accomplish writing objectives.
Sociobehavioural	Learning mode	Interaction among students using editing and video meeting features virtually.
		Collaborative writing including the adoption of real-time feedback using virtual worksheets.
		Synchronous and asynchronous feedback handled by teachers and students.
	Ecological	Technological support accessed freely by students.
		Heterogeneous grouping among students to provide robust output.
		Teacher support of giving feedback and supervision.
	Individual Support	Willingness to share ideas and insights in a collaborative work atmosphere.
		Student open-minded to learning feedback and revising.
Motivational Regulation	Learning mode	Student developed writing mindset and objective settings.
	Ecological	Teacher pedagogical mediation to maintain student motivation.
		Adaptive and engaging virtual learning atmospheres.
	Individual Support	Student enjoyment of the writing process.
		Student coping strategy and survival during the writing process.

and work together through video conferences and editing, using various features to promote diverse viewpoints. Effective social learning required both synchronous and asynchronous communication and feedback handling. By using the online SRWA, the teachers supported students in a collaborative, real-time environment by offering supervision and feedback. Students were motivated to actively participate and share insights concerning the writing process, further described in the following script:

[S2] ...classroom discussion, peer work, and teacher feedback tend to optimize the quality of my writing. Even the online platform offered unlimited time, learning was not limited by physical attendance on site since one could engage in virtual conferences, peer feedback, including holding synchronous and asynchronous discussions.

Considering the motivational regulation aspect, the obtained data showed that teachers contributed significantly to maintaining and fostering a fun and flexible virtual environment. The student growth mentality, coping mechanisms, and enjoyment of the process were focused on, outlining the need for an engaging learning environment that aids in overcoming obstacles and achieving writing objectives.

DISCUSSION

Students' Perceptions of AI Utilization in Online SRWA

This research explores student perspectives on AI use, including how these tools support writing skills and learning autonomy. The findings imply that AI is viewed positively in respect to self-regulation strategies, recognizing it as a tool for assisting vocabulary selection (Yunjiu et al., 2022), organizing insights (Marzuki et al., 2023), and boosting critical thinking (Zou & Huang, 2024). The students accept immediate feedback, which promotes learning autonomy by recognizing and revising errors independently. AI also reduces writing task anxiety and fosters a positive learning environment, which is supported by previous research (Chiu et al., 2024; Kim et al., 2025; Liu, 2024). The research shows that AI has the potential to serve as a useful tool in contemporary education when it is applied in conjunction with human direction and instruction rather than as a substitution for it (Alkhateiri, 2022).

The relationship between online SRWA and learning autonomy has been the focus of recent research, with findings outlining the role of digital platforms in promoting autonomous learning behaviors. Online SRWA helps develop a greater sense of autonomy by motivating students to set personal objectives and monitor and evaluate their progress and accomplishments (Guay, 2022). Furthermore, students are frequently allowed to take charge of the learning process, which enables them to acquire critical self-assessment and time-management skills (McIver & Murphy, 2023). Incorporating technology into writing instruction fosters a greater sense of responsibility and engagement and helps enhance relevant skills (Liu et al., 2023; Morris & Rohs, 2021).

AI is being used more often in self-regulated writing tasks, presenting remarkable opportunities, challenges, impacts, and limitations. AI tools such as grammar checkers, style editors, and personalized feedback systems are examples of how these technologies offer real-time and individualized support that empowers students to evaluate and improve their writing abilities independently (Almufareh et al., 2024; Al-Sofi, 2024;). Additionally, AI-powered platforms provide adaptive feedback that can be altered according to learner performance and development, which promotes student perseverance and self-improvement (Du et al., 2025). Alwaqdani (2025) reported that AI-powered tools provide benefits for students to enhance learning autonomy and digital readiness.

Despite its beneficial contributions, the integration of AI into online SRWA also presents numerous challenges. For example, students without a basic writing capacity tend to use AI tools and get accustomed to automated edits (Hyland, 2019). Additional difficulties include privacy issues and data security because AI systems frequently need access to personal information to offer customized assistance, which raises ethical considerations (Royackers et al., 2018). Finally, accessibility issues, such as the availability of advanced AI tools only to students with certain resources, lead to inequities in learning opportunities. Effective and equitable use of AI in educational settings requires remarkable balance between these issues and the technological ability to improve self-regulated writing. The present research is in line with the findings by Wale and Kassahun (2024), who stated

that the adoption of AI-powered tools outperformed conventional classes with similar challenges found during related activities.

In addition to the challenges identified, the use of AI in online SRWA has negative implications for students' learning autonomy. Firstly, excessive reliance on AI impedes students' critical thinking abilities, as they often prioritize AI-generated suggestions over their own analysis and problem-solving. This over-reliance ultimately limits their capacity to construct persuasive arguments in their writing (Marzuki et al., 2024). As a result, this dependence hinders the development of critical thinking skills, preventing students from effectively evaluating evidence, integrating diverse perspectives, and constructing coherent arguments. Secondly, AI utilization negatively impacts students' cognitive and metacognitive writing processes by reducing their active involvement in generating ideas, organizing arguments, refining writing style, developing independent revision techniques, and setting personal goals (Umamah & Cahyono, 2022). Furthermore, Abbes et al. (2024) highlighted that AI-generated content often lacks context-specific accuracy, making it less effective in addressing the individualized learning needs of students. Therefore, while AI can support students in their writing endeavors, it should serve as a complementary tool for learning how to develop their writing (Umamah et al., 2022).

Despite these contributions and challenges, this study also presents several limitations that warrant further investigation. First, the survey data constrains the depth of analysis, as self-reported measures are subject to biases such as social desirability and individual interpretation of autonomy (Zhai et al., 2024). Moreover, the absence of classroom observation limits the ability to capture real-time interactions between students and AI tools, which are crucial for understanding their impact and engagement (Fathi & Rahimi, 2024). Future research should employ mixed-method approaches to provide a more nuanced analysis, particularly regarding AI's impact on students' critical thinking, creativity, and argumentation skills (Abbes et al., 2024).

Factors Contributing to Students' Role in AI Utilization in Online SRWA

The main objective of this research was to examine the factors influencing the active role of students in using AI. The findings show that

numerous important factors support the successful application of these tools in the learning context. First, regarding learning mode, real-time feedback promotes independent problem-solving through a virtual environment that allows the identification and revision of errors without immediate teacher intervention (Kim & Hannafin, 2011). Second, the ecological aspect is important because AI tools offer diverse, multidimensional resources and constructive suggestions for improving writing skills that promote student adoption of self-regulated strategies. This finding is in line with research by Lim et al. (2023), who reported that personalized technological support contributes to self-regulation skills. Third, the individual support factor is important for student digital literacy and their openness to ideas that support students' learning in the online environment.

Learning mode is a critical factor influencing how students engage with AI tools in online SRWA. Specifically, asynchronous and synchronous learning modes affect students' interactions with AI differently, shaping their ability to incorporate feedback and independently adjust their writing practices (Seo et al., 2021). For example, in asynchronous learning, students frequently have more time to examine AI-generated feedback at their own pace, which enables them to ponder more deeply and evaluate themselves (Rodafinos, 2024). By encouraging more deliberate use of AI resources, this mode helps students build self-regulated learning skills and a sense of autonomy (Cárdenas-Robledo & Peña-Ayala, 2019). Synchronous sessions offer the advantage of immediate teacher support, which can complement AI feedback and help students clarify doubts or refine their writing approach in real time (Kostka & Toncelli, 2023). The balance between these modes and flexibility of each can empower students to use AI tools optimally according to their personal learning preferences, ultimately supporting more autonomous and effective learning process (Srinivasan, 2022).

The ecological factor, which was originated by Bronfenbrenner (1979), includes institutional support, access to resources, and technological infrastructure, which significantly impacts how students apply AI to online SRWA. For example, students' use of AI technologies is greatly affected by the availability of modern devices and

the quality of the internet connection. According to previous research, students with access to fast internet and cutting-edge technology are better positioned to leverage AI for real-time feedback and iterative self-assessment, thus enhancing their capacity for self-regulated learning (Morrison & Jacobsen, 2023). Furthermore, institutional support systems such as capacity-building sessions, technical assistance, and access to digital libraries help students feel confident and competent when utilizing AI technologies (Chen et al., 2023; Strobl et al., 2019). Thus, the ecological setting plays a pivotal role in determining how holistically students can integrate AI into their education and highlights the need for educational institutions to give equal access and make digital infrastructure a strong priority of to maximize AI's advantages in self-regulated learning environments (Kinshuk et al., 2016).

The successful application of AI in online SRWA depends heavily on individual factors. First, students' use of AI tools is greatly influenced by their language skills because the more proficient students better utilize AI to improve the complexity, coherence, and quality of their writing (Zhai & Wibowo, 2023). Furthermore, students who are open to new ideas and willing to try new things are more likely to successfully incorporate AI into their writing processes (Dwivedi et al., 2023). In self-regulated learning environments, self-management abilities such as goal-setting, time management, and self-monitoring are essential for optimizing the advantages of AI (Li et al., 2024). The present research findings are supported by previous findings that mention that individual support plays a pivotal role in integrating AI into self-regulation strategy in the writing context for an online environment (Jin et al., 2023; Wang & Lin, 2023).

The relationship between the factors of learning mode, ecology, and individual support is pivotal for promoting student autonomy in AI integration in online SRWA. The learning modes, both synchronous and asynchronous, influence students' use of AI tools for self-regulation. Ecological factors, the supportive digital ecosystems that include easily navigable AI interfaces and easily available online resources can improve students' comfort and engagement with AI. Individualized support, like personalized feedback or guidance on AI tool usage, further reinforces self-regulation. When

students receive tailored support, they gain confidence in their ability to navigate AI independently (Roberts et al., 2025), boosting both self-regulation (Graham & Harris, 2018) and autonomy (Liu et al., 2023) in writing activities.

Implications and Limitations

The implications of these findings are significant for educational practices. To successfully integrate AI, teachers must help students comprehend its potential and limitations, highlighting AI as an adjunct to human supervision rather than a substitute (Tubaro et al., 2020). Furthermore, as AI promotes self-regulated learning, digital literacy instruction must be integrated into AI to guarantee that students can use these resources independently. In line with the educational objectives of encouraging self-directed and lifelong learning, this strategy may improve students' motivation, perseverance, and ownership over their learning outcomes. In the end, the study emphasizes that effective AI use in online learning settings requires a comprehensive strategy and professional development for both students and teachers that takes into account both pedagogical and technological aspects (Wang et al., 2020).

This study presents several limitations that call for upcoming research recommendations. First, the interview data limit the generalizability of the findings, as participants' responses are inherently subjective and are shaped by individual experiences, potentially leading to interpretive biases. While the study identifies critical factors (learning mode, ecological conditions, and individualized support) that influence students' role in utilizing AI tools, the absence of a comparative analysis of students' writing performance restricts a more nuanced understanding of how these factors contribute to learning autonomy. Furthermore, the study does not account for variations in students' technological proficiency, which significantly affects their ability to integrate AI tools effectively into autonomous writing practices, thereby limiting the broader applicability of the findings.

CONCLUSION AND RECOMMENDATION

Students perceive AI use in online SRWA as a valuable tool for promoting autonomy. The participants express positive views regarding the role of these tools in enhancing classroom practices. Additionally, the active use of AI tools enables students to assume greater responsibility in

objective-setting, monitoring, and self-assessment and fosters a more autonomous learning experience.

The research identifies three key factors contributing to the successful implementation of AI-supported self-regulated writing: the learning mode, ecological factors, and individual support from students. The learning mode is crucial in offering flexibility and access to AI tools that accommodate continuous writing development. In the ecological aspect, peer collaboration, teachers' support, and the digital environment are encouraged to enhance self-regulation skills and learning autonomy. Finally, individual support elements, including motivation, self-efficacy, and flexibility, are crucial in online SRWA. These results indicate the great potential for using AI in self-regulated writing activities.

Future studies should explore the long-term effects of AI utilization in online SRWA on students' learning autonomy across diverse educational settings. Research might examine particular AI tools and their efficacy in various stages of the writing process to ascertain which elements most strongly influence self-regulation and autonomy, including brainstorming, drafting, rewriting, and final editing. Furthermore, analyzing the impact of learner attributes like motivation, competency levels, and technology familiarity can reveal ways to customize AI to suit specific requirements. A comparison approach might also be used to identify the best implementation strategies, evaluating the efficacy of AI-assisted self-regulated writing in online versus mixed-learning environments. Future research should also look at the ethical and social issues surrounding AI in education, such as worries about algorithmic bias, data privacy, and the possibility of academic dishonesty. In order to ensure that the AI serves all students equally, while maintaining academic integrity and safeguarding personal information, it is imperative that clear criteria for ethical AI use in education be established.

ACKNOWLEDGEMENTS

We would like to thank the Center of Academic Research Services (Puslapdik) of the Ministry of Research, Technology and Higher Education and the Indonesia Endowment Fund for Education Agency (LPDP) of the Ministry of Finance of the Republic of Indonesia for research grant funding.

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