

AI USE AND IMPACT ON METACOGNITIVE STRATEGY OF ESL LEARNERS IN HIGHER EDUCATION

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Abstract. The use of Artificial Intelligence (AI) in education is still being debated. People who embrace AI may argue that if applied wisely can lead to unprecedented discoveries and new ideas for research. However, others feel that the use of AI diminishes originality and creativity due to dependency on AI tools. Students when using AI need to be critical and aware of the existence of biasness and inaccuracy of information gained. Hence, this study is aimed to identify the frequency of AI use and its impact on metacognitive strategies. A total of 241 from an undergraduate ESL programme of a local university in Malaysia participated in the study by answering a survey. The survey yielded that the main metacognitive strategy was ‘Searching other references.’ In addition, it was found that there is a weak relationship between the frequency use of AI and critical use of metacognitive strategies. This study highlights the importance of strategy awareness among the students so that they can harness the benefits of using AI in their everyday academic life.

Keywords: *Artificial intelligence (AI), AI use frequency, AI literacy, metacognitive strategies, strategic ESL language learning*

Introduction

Artificial Intelligence (AI) has permeated almost all aspects of our lives, i.e. transportation, healthcare, entertainment and education. In 2016, Stanford University released a “100-year report on AI” that looked into eight domains related to AI (transportation, home/service robots, healthcare, education, low-resource communities, public safety and security, employment and workplace, entertainment). For education, it was reported that quality education requires active engagement by human teachers, whereas AI would enhance education providing personalization, self-paced and individualized learning (Stone et al., 2022). The use of AI has become more prevalent due to its capabilities of enhancing almost all aspects of everyday human lives. Nonetheless, educators are becoming concerned mostly about students’ dependency on using AI at every corner of their academic path. It challenges educators to distinguish between student-authored and AI-assisted work, ensure fairness, and adapted rubrics (Fleckenstein et al., 2024). Other concerns are the potential bias in output, the possibility of human oversight, and the potential for misuse of information. As a result, this leads to the issue of a robust assessment to ensure integrity and fair education. However, if AI is handled carefully and strategically, these concerns can become opportunities. As learners, students need to become more familiar with potential societal biases and risks of AI applications (Roe et al., 2023; Selelo, 2023). Roe et al. (2023) in reviewing AI assisted writing tools recommended more research to be done in order to investigate the ramifications towards education policies. There are numerous available AI tools if used wisely may benefit all aspects of education like research, curriculum

development and even assessment. However, AI like Perplexity for example is able to find and synthesize information from various articles. Though this is time saving and efficient, will learners be able to repeat or imitate the process without AI? The frequency of referring to AI may undermine critical thinking if learners depend too heavily on AI for answers.

Presently, there is a lack of comprehensive reviews available on the impact of AI-based language learning tools on the pedagogical and learner perceptions of these tools. Existing reviews related to AI in language learning have focused on only a specific type of AI-based tool or the overall impact of AI on the future of language education. The extent to which AI impacts on the learners' cognitive capabilities is still under-researched. Thus, the present study is to investigate the impact of the frequency use of AI on their metacognitive reading strategies. Therefore, the research questions are as: (1) What are the metacognitive reading strategies used while reading responses from AI? (2) Is there a significant relationship between frequency of AI use and the number or type of metacognitive strategies employed?

Literature review

Overview of AI use in ESL education

AI has evolved significantly in language learning and teaching. The use of AI in language learning started in the 1980s during the introduction of personalized education (Kannan and Munday, 2018). AI providers and deployers constantly make improvements to meet the demands of the sophisticated users. In language learning, AI is regarded as beneficial in speaking and writing. For instance, early AI like Siri and Alexa help to answer questions and pronounce words in English. AI shows great promise for language learning for its capabilities to personalize learning and mimic natural language acquisition (Campbell, 2023). Presently, corrective tools like Grammarly and Quillbot were popular in enhancing writing skills (Roe et al., 2023; Woo and Choi, 2021). ChatGPT, Claude, Gemini, DeepSeek and Perplexity help learners to source information in any given topic and enhance their writing output. Besides becoming a platform to practise language, AI has created not only a new language learning environment, but also research areas. Linguistic researcher, Ali (2020) found that these AI platforms enable the researchers to identify the linguistic coping strategies of language learners. The use of AI in psycholinguistics is important as it can analyze the natural language processes in humans (Ali, 2020). AI has become integral in language teaching and learning due to its various benefits.

Importance of metacognition for ESL students

Strategic learning behaviors, particularly in ESL contexts, refer to the strategic use of cognitive and metacognitive strategies that facilitate language development. Flavell (1979) describes metacognitive strategy as a mechanism that helps learners to monitor and regulate learning. This strategy is perceived as a higher order cognitive skill due to its role in overseeing other cognitive skills (Flavell, 1979). O'malley and Chamot (1990) define metacognitive strategies as, ‘..higher order executive skills that may entail planning for, monitoring or evaluating the success of learning activity’. In relation to ESL learning, research studies have begun to focus on metacognitive skills (Rianto, 2022; Hamid et al., 2020; Ahmadian and Pasand, 2017; Azmuddin et al., 2017; Darwish, 2017; Ramli et al., 2011). Researchers such as Anderson (2002) as well as

Mokhtari and Sheorey (2002) emphasize the use of metacognitive skills in L2 reading. In further research on ESL metacognitive skills, they indicate that inculcating awareness and giving training of metacognitive strategies to learners are integral aspects in ESL reading classrooms. Anderson (2002) emphasizes that metacognition enables ESL learners to regulate their reading comprehension and language production more effectively. As Anderson (2002) mentioned, reading effectively is one of the most essential skills that teachers can help L2 learners develop as it leads to the success of language learning. For ESL learners, being able to make the distinction between effective and ineffective learning strategy proved to be beneficial. In L2 learning, the success of an L2 learner is profoundly affected by his ability to monitor or edit his own learning process (Krashen, 1982; 1981). Mokhtari and Sheorey (2002) classify metacognitive reading strategies into global, problem-solving, and support strategies. Anderson (2002) classifies metacognitive reading strategies of L2 learners further into five primary components: Preparing and planning for effective reading, deciding when to use particular reading strategies, knowing how to monitor reading strategy use, learning how to orchestrate various reading strategies and evaluating reading strategy use. Several research using Anderson's metacognitive strategies categories yielded different outcomes depending on the population and purpose of reading (Rianto, 2021; Hamid et al., 2020; Azmuddin et al., 2017; Ramli et al., 2011).

Past studies describe that metacognition takes place in 4 phases: Tacit, Aware, Strategic and Reflective. This framework provides a point of reference for teachers to monitor students' metacognition development and training. The four levels were introduced by Perkins (1995). The first level of metacognition is tacit which means a student understands the task that is given to him or her. Usually, a teacher can help trigger this strategy by assigning or setting a goal for them. As the students embark on completing their task, the students are aware and choose strategies to employ that would be effective. He may be using tools to take notes while reading. The student is being a strategic learner when he recognizes and monitors the various strategies. As he enters the reflective phase the student will question and evaluate the task that he is given. Strategic learners organise their thinking by solving problems, grouping and classifying, evidence-seeking and decision-making. They apply strategies that help them learn. Hence, metacognition helps students to become independent learners, which are essential for ESL learners especially when navigating AI-generated content. Learners who use metacognitive strategies are probably able to achieve more. Research shows that improving a learner's metacognitive practices may compensate for any cognitive limitations they have. The main challenge for teachers is to identify how their students manage their own learning processes. Perkins' framework situates metacognition not just as a cognitive skill, but as a mindset that empowers learners to take control of their learning, adapt strategies to different tasks, and become more thoughtful, independent thinkers. He advocates "thinking dispositions," such as curiosity and reflectiveness, which support metacognitive growth (Perkins et al., 1993).

AI literacy and strategic learning in ESL learners

AI literacy refers to an individual's ability to critically understand, evaluate, and effectively use artificial intelligence technologies. Most importantly is to use AI and participate ethically in the digital world. In the context of ESL learning, AI literacy encompasses the skills needed to navigate AI tools such as language models (e.g., ChatGPT, Claude, Perplexity), grammar checkers, speech recognition systems, and

translation apps for academic and communicative purposes. According to Ng et al. (2021), AI literacy involves not only technical understanding but also critical thinking, ethical use, and awareness of limitations and biases inherent in AI systems. Root et al. (2025) emphasizes that in AI literacy legal compliance is paramount to ensure responsible AI governance. Thus, for ESL learners, AI literacy supports language acquisition through enhanced access to immediate feedback, personalized learning, and exposure to authentic input and output (Kasneci et al., 2023). One of the four major skills in language acquisition is reading. Hence, the ability to read effectively in the AI era requires effort from the reader in making mental connections between text or online text and his existing knowledge with the assistance of reading tools available to them. The strategy or ability to monitor and adapt one's reading skills during a reading task is the determining factor to successful reading. Reading is a highly interactive cognitive process (Nuttall, 1996; Carrell et al., 1988; Anderson and Pearson, 1984). A reader connects or activates his background knowledge or schemata to understand a particular text. During this reiterative process a reader employs several reading strategies simultaneously. A successful reader is able to execute the strategies effectively while reading a given text. Deeper comprehension is achieved if the reader is able to self-regulate and monitor his own strategies (O'malley and Chamot, 1990; Flavell, 1979). Research has been done on reading online and metacognitive strategies, however, with the surge of AI application in the academic world, the impact of AI during the reading process should be revisited (Rianto, 2022; Mohd Ramli, 2021; Ahmadian and Pasand, 2017; Ramli et al., 2011; Anderson, 2002; Darwish, 2017). Readers nowadays are reading on multiple digital AI platforms that enables them to enjoy reading or enhance their knowledge (Tazijan et al., 2022; 2019; Liman Kaban and Karadeniz, 2021; Singer and Alexander, 2016). Zápotočná (2016) postulates that new literacy or knowledge gained be it reading online or offline entails the same information processing as it is both cognitive process in order to add new information. Therefore, metacognitive strategies are crucial during the search for information phase where readers are more interested to find various information sources (Zápotočná, 2016).

AI usage patterns affect ESL learners' strategic thinking

The integration of AI tools into ESL learning is not anything new. However, it requires learners to apply both AI literacy and strategic learning behaviors in order to ensure engagement and learning. Effective learners do not use AI passively; instead, they critically assess outputs, cross-reference sources, and adapt their language usage accordingly (Roe et al., 2023). The interplay between AI literacy and strategic learning supports deeper engagement with language input and fosters learner autonomy, both of which are critical for long-term language development. Despite the increasing integration of AI in ESL education, research on examining the use of AI that influences strategic thinking among ESL learners remains underdeveloped. The extent students self-check or self-regulate their learning outcomes should not be an oversight. Most existing research focuses on functional and productive skills such as grammar improvement, vocabulary building, and writing support (Kasneci et al., 2023; Woo and Choi, 2021), while neglecting the cognitive impacts of habitual AI use. As a result, little is known about how different frequencies or patterns of AI engagement affect ESL learners' ability to plan, monitor, and evaluate their own learning which is a process central to metacognition (Anderson, 2002; Flavell, 1979). Findings by Ramli et al. (2024) show that students frequently use AI to brainstorm and enhance assignments yet

demonstrate low levels of monitoring and self-reflection. Thus, it raises concerns that excessive dependency on AI tools could bypass deeper cognitive processing, leading to surface-level learning behaviors or less critical thinking. Moreover, Roe et al. (2023) argue for more attention given to the implications of AI tools on learner autonomy and critical thinking in academic contexts. As AI becomes more embedded in education, a clearer understanding of how usage intensity correlates with strategic learning behaviors is needed. Bridging this gap is essential for designing ESL instruction that promotes ethical, reflective, and autonomous AI use.

Materials and Methods

To answer the research questions, this study adopted a quantitative approach. 241 students from an ESL language programme from a local university in Shah Alam, Malaysia, responded to the survey. The survey was developed based on Perkin's category of metacognitive strategies and distributed via Google form. The survey aims to describe the ESL learners' metacognitive reading online strategies while using AI. Part A of the questionnaire elicited the demographic data of learners who were involved in the study. The frequency of using AI is included in this section. The data were analysed using descriptive statistics to give an overview of the characteristics of the selected population. Both descriptive and statistical tests were used to analyse the data. Part B of the questionnaire, the learners were required to identify the metacognitive strategy used during reading online and using AI. The survey listed 8 metacognitive strategies. These metacognitive strategies are selected based on the Perkin's 4 categories of metacognition which are tacit, aware, strategic and reflective. Data was analysed using descriptive statistics, applying both graphical and numerical techniques in SPSS and Microsoft Excel programmes. Statistical techniques such as test for normality, percentages, mean and standard deviation and coefficient of variation test (CV) to identify the significance of the strategies.

Results and Discussion

Metacognitive reading strategies used while reading responses from AI

The data showed that there were 67.6% female and 32.4% male students. The major findings of the survey are as follows. The students were asked about the activities while they were using AI, which are metacognitive strategies. They were asked to tick all the related metacognitive strategies. Their responses were tabulated in percentages. *Table 1* depicts the findings. The data in *Table 1* shows that the most frequent metacognitive strategy used by these language students was 'Searching other references' (62.7%). In this Strategic phase, according to Perkins (1992), the student not only broadens their understanding but also evaluates the credibility and relevance of the information they encounter by looking at other sources, platforms or media. This strategy helps them to minimize biases and increase the accuracy of information. This critical metacognitive strategy enhances learning and academic performance. The next metacognitive strategies that are frequently used are 'Questioning yourself while reading' (54.8%) closely followed by 'Evaluating responses' (54.4%). By questioning themselves, the student actively engages with the material, leading to better understanding and retention of the information. By constantly questioning and evaluating while reading, Anderson

(2002) explains that these strategies are indicators that the students have the ability to evaluate the reading texts in terms of completeness of argument, validity and credibility of sources. The strategy 'Monitoring yourself while reading text' MR5 (38.2) scored the lowest percentage. Monitoring refers to the ongoing process of tracking and reviewing one's understanding and performance during a learning activity (Fiedler, Ackerman & Scarampi, 2019). It is the awareness of one's cognitive processes and making adjustments as needed to enhance comprehension. Monitoring oneself while reading can be a fundamental process and near advanced strategy depending on the context. In this case of this study, while using AI in reading resources, the students rate this strategy the lowest.

Table 1. *Metacognitive strategies used while reading responses from AI.*

Category	Metacognitive strategies	Percentage (%)
MR1	Setting a goal/ purpose	43.2
MR2	Evaluating responses	54.4
MR3	Seeking clarification for the responses	51.9
MR4	Questioning yourself while reading	54.8
MR5	Monitoring yourself while reading text	38.2
MR6	Taking notes of the responses	51
MR7	Searching other references	62.7
MR8	Summarising the responses	43.2

Significant relationship between frequency of AI use and the number or type of metacognitive strategies employed

Table 2 presents the Spearman's rank-order correlation analysis between the frequency of AI technology usage and a range of metacognitive reading strategies used while reading responses from AI. There was a negative correlation between the frequency of AI use and the strategy of setting a goal or purpose ($r_s = -0.125$, $p = 0.070$). However, this relationship was not statistically significant at the 0.05 level, indicating that frequent AI users were not significantly less likely to set learning goals or purposes compared to less frequent users. A statistically significant negative correlation was observed between AI usage frequency and evaluating responses ($r_s = -0.135$, $p = 0.050$). This suggests that individuals who use AI more frequently tend to engage slightly less in evaluating the responses they receive. Despite that the correlation is weak, the finding is noteworthy as it points to a potential decline in critical evaluation behaviours with higher AI dependence. The correlation between AI usage frequency and seeking clarification was negative but not significant ($r_s = -0.092$, $p = 0.181$). This indicates no meaningful relationship between how often one uses AI and their likelihood to seek clarification about the responses they receive. No significant correlation was found between the frequency of AI use and self-questioning during reading ($r_s = -0.054$, $p = 0.438$). This suggests that AI usage does not meaningfully impact reflective or metacognitive questioning behaviours. A negative and non-significant correlation was observed between AI usage and monitoring behaviour ($r_s = -0.119$, $p = 0.084$). While this might imply a trend where frequent AI users are less likely to monitor their understanding while reading, the result lacks statistical significance. The correlation between AI use and taking notes was also negative and non-significant ($r_s = -0.108$, $p = 0.119$), suggesting no clear association between frequent AI use and the practice of note-taking. A near-zero correlation was found between AI usage and the behaviour of

searching other references ($r_s=0.018$, $p=0.790$), indicating absolutely no relationship between the two variables. A statistically significant negative correlation was found between the frequency of AI usage and the strategy of summarising responses ($r_s=-0.156$, $p=0.024$). This suggests that individuals who frequently use AI may be less inclined to summarise information, possibly relying more on the AI's outputs rather than engaging in deeper processing or synthesis of information themselves.

Table 2. Correlation analysis between the frequency of AI technology usage and metacognitive reading strategies used while reading responses from AI.

How often do you use AI technology?		
Set a goal/purpose	Correlation coefficient	-0.125
	Sig. (2-tailed)	0.07
	N	211
Evaluating responses	Correlation coefficient	-.135*
	Sig. (2-tailed)	0.05
	N	211
Seek clarification for responses	Correlation coefficient	-0.092
	Sig. (2-tailed)	0.181
	N	211
Questioning yourself while reading responses	Correlation coefficient	-0.054
	Sig. (2-tailed)	0.438
	N	211
Monitoring yourself while reading responses	Correlation coefficient	-0.119
	Sig. (2-tailed)	0.084
	N	211
Taking notes of responses	Correlation coefficient	-0.108
	Sig. (2-tailed)	0.119
	N	211
Searching other references	Correlation coefficient	0.018
	Sig. (2-tailed)	0.79
	N	211
Summarising responses	Correlation coefficient	-.156*
	Sig. (2-tailed)	0.024
	N	211

Note: * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

Conclusion

Effective learners employ all of metacognitive strategies strategically, beginning with monitoring and advancing to more complex processes to enhance their learning outcomes. This study illustrates that students utilized a range of metacognitive strategies while using AI to complete their assignments. 'Searching other references' emerged as the most frequently used strategy which reflects a proactive and critical approach to learning. Conversely, the least used strategy was 'Monitoring oneself while reading' which suggests a potential area for instructional focus. The correlation analysis further reveals that increased frequency of AI usage is weakly associated with critical strategies like evaluating and summarising responses. This finding indicates that heavy reliance on AI might discourage deeper cognitive engagement. Although most correlations were not statistically significant, this highlights the need for balanced AI integration in learning.

These findings could assist educators in understanding the strategies involved when students use AI and how they perceive the purpose or benefits AI can offer to them. Educators should ensure AI serves as a tool to support, rather than replace, reflective thinking. It is suggested that future studies should include more variables like age, gender or academic background to gauge the impact on each other. Investigate how students' competency in using AI tools relates to their academic success and whether improving AI literacy can enhance learning outcomes. It is also recommended to utilize qualitative methods such as interviews or focus groups to gain deeper insights into students' experiences, perceptions, and challenges related to using AI and metacognitive strategies.

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Conflict of interest

The authors declare that they have no conflicts of interest related to this manuscript.

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