



EMPOWERING ESL STUDENTS WITH AI: ENHANCING ACADEMIC READING AND AUTONOMY

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Abstract

Academic reading is a continuous challenge for English as a Second Language (ESL) students in higher education because they need to understand unfamiliar academic language while also acquiring the research-literacy skills necessary to read and work independently with academic texts. The current study conducted an eight-week, classroom-based intervention that involved 64 ESL undergraduate and postgraduate students to four AI-based literature and reading-support tools (Connected Papers, Consensus, Scholarcy, and SciSpace) in a scaffolded task sequence that began with literature discovery and ended with critical synthesis. The research was designed as an explanatory sequential mixed methods design, which included pre-post academic reading test, learner-autonomy questionnaire, research-literacy checklist, semi-structured interviews, and classroom observation. Students' reading scores increased statistically significantly ($M = 62.4$ to $M = 76.1$, $d \approx 1.48$) and their self-reported autonomy scores increased statistically significantly ($t(63) = 6.42$, $p < .001$), with the greatest gains in resource selection and inference. The results indicate that AI tools for discovery and summarization can be a valuable addition to reading instruction and learner autonomy when integrated into an explicit and instructional design. Future studies can provide a transferable task sequence for ESL teachers who want to shift their students from ad hoc use of AI to systematic, autonomy-oriented academic reading instruction.

Keywords: *Academic Reading, Artificial Intelligence, ESL, Learner Autonomy, Mixed-Methods, Research Literacy.*

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1. Introduction

Academic reading in English is one of the most challenging skills that English as a Second Language (ESL) learners need to acquire in higher education. At the tertiary level, students are required to not only understand complex texts but also to critically engage with scholarly texts, to synthesize multiple texts and to build arguments based on evidence (Hyland, 2016; Flowerdew & Peacock, 2001). The heavy demands of academic writing, the specialized vocabulary of the discipline, and the unfamiliar rhetorical patterns of academic writing often cause ESL students to become frustrated and use superficial reading strategies (Grabe, 2009; Paltridge & Starfield, 2007). This is exacerbated by the fact that traditional reading instruction focuses on sentence and paragraph level comprehension, rather than the more research-oriented practices students need to develop in order to be able to read independently and as a novice researcher (Nation, 2009; Zimmerman, 2008).

Although research literacy and digital competence are increasingly being emphasized in the curriculum, still many ESL students are not sufficiently prepared to read academic texts independently (Lea & Street, 2006; Li, 2017). They have a tendency to find the relevant literature, assess the credibility of sources, and understand the methodological and evidential structure of research articles (Anderson, 2003; Bruce, 2008). Meanwhile, AI tools for literature discovery and summarization, such as Connected Papers, Consensus, Scholarcy, and SciSpace, have proliferated and, in recent systematic reviews, have been linked to measurable improvements in reading comprehension, vocabulary, and fluency when used in structured, teacher-led activities (Qi et al., 2025; Theodorus et al., 2024). The overall ESL/EFL literature also confirms the positive effects of AI-supported teaching in various language skills, which are influenced by the length of the intervention, the type of task, and the characteristics of the learners (Manzoor et al., 2025; Jeon, 2025).

However, in many ESL classrooms, these tools are used in an ad hoc and unguided way, either because they are limited due to concerns about the loss of critical thinking, or because they are implemented without pedagogical scaffolding (Bennett & Maton, 2010; Hockly, 2023). Without proper structure, this pattern can lead to reliance on AI-generated summaries, lack of critical engagement with the content, and limited incorporation into research-literacy skills. The present study is motivated by this gap, which is the availability of powerful AI tools and the lack of instructional designs that explicitly promote autonomy and criticality in conjunction with these tools.

1.1. Research Objectives

1. To design and implement an eight-week academic reading intervention for ESL university students, with the use of AI tools.
2. To check the difference in ESL students' self-reported autonomy and research-literacy practices before and after the intervention.

1.2. Research Questions

1. How effective is an eight-week intervention with AI tools on academic reading scores for ESL students.
2. What is the difference in ESL students' self-reported autonomy and research-literacy practices before and after the intervention?

2. Literature Review

2.1. AI and Academic Reading in ESL

There is an increasing amount of empirical evidence that AI tools can aid in vocabulary acquisition, comprehension, fluency, and influence students' motivation and self-regulation. In a 2025 systematic review of AI reading tools in ESL/EFL settings, six common types of AI reading tools were identified, including chatbot systems, intelligent tutoring systems, adaptive reading platforms, speech-based applications, multimodal tools, and natural language processing applications, with consistent positive effects found on comprehension, vocabulary, and fluency, especially when the tools were integrated into teacher-led activities rather than used freely (Qi et al., 2025). The findings of a parallel systematic review that specifically examined the use of AI tools in Malaysian ESL classrooms were similar: AI tools were associated with improvements in a number of specific themes of reading skills and were found to be flexible across age groups, but the evidence base was still limited compared to the extent of their current use (Theodorus et al., 2024).

At the university level, recent research continues this picture to other contexts of English teaching. In a university English teaching context, Guo et al. (2025) demonstrated that an AI-based mobile learning platform could enhance students' motivation and practical language skills compared to traditional teaching methods, and suggested that AI-based platforms can be used to promote global cooperation and fair access to education when they are used purposefully and not just as a standalone tool. The results of the quasi-experimental study conducted by Al-Nawaiseh (2026) on a mobile AI reading application with Jordanian primary school students also support this conclusion, as the AI-supported group showed significantly higher reading gains than the traditionally taught control group, indicating that the advantages of AI-mediated reading support are not limited to advanced or university-level learners, although the magnitude and type of the effect may vary with age and proficiency.

In all of these studies, researchers warn that benefits are dependent on pedagogically purposeful use. If students are not explicitly taught AI literacy and critical reading, they may become too dependent on AI-generated summaries and fail to engage with the original texts (Hockly, 2023; Manzoor et al., 2025). AI tools that streamline language and offer concise summaries can serve as useful scaffolds for ESL learners who are already struggling with cognitive overload from dense academic writing, provided they

are used in conjunction with other strategies, such as self-regulated reading and metacognitive reflection (Nation, 2009; Hyland, 2016).

2.2. Autonomy, Self-Regulated Learning, and AI

The concept of learner autonomy in ESL is generally understood as the ability to set goals, choose resources, time management, self monitoring, and strategy adaptation to task demands (Benson, 2011; Zimmerman, 2008). In academic reading, autonomy also means selecting texts that are suitable for them, slowing down, rereading, summarizing, and asking for assistance, which are increasingly mediated by AI tools in today's classrooms (Grabe, 2009).

Empirical studies on the role of AI and autonomy in L2 learning in recent years provide a complex picture. The study by Nguyen and Doan Thi Hue (2025) compared the ChatGPT-facilitated and teacher-facilitated project-based learning groups in terms of gains in learner autonomy, finding that the former group made significantly higher gains in learner autonomy, and qualitative data revealed that the use of AI in project-based learning changed students' perception of what autonomy means and led to more initiative and experimentation. This aligns with the wider argument that AI can help students to be more 'active, self-regulated' learners, if it is presented as a personalised, feedback-rich tool, rather than a passive answer machine (Holmes & Littlejohn, 2024).

Meanwhile, the broader ESL/EFL literature has raised concerns about the impact of AI on self-regulation and autonomy, which is not guaranteed but rather hinges on the length of the intervention, the design of the interface, and the explicit scaffolding of critical use by the teacher (Jeon, 2025). This means that ESL teachers should view AI tools as socio cognitive artifacts that can support or hinder autonomy, depending on how they are designed and used in the classroom. AI can be used strategically to enhance metacognitive awareness and self-regulation, for example, by having students compare AI-generated summaries with the original texts or by explaining their choices of sources (Benson, 2011). This study aims to equip students with the skills to effectively utilize research tools and AI-based discovery tools in ESL settings.

In higher education, research literacy is defined as the capacity to find, assess, combine, and ethically utilize academic resources in their field of study (Bruce, 2008; Lea & Street, 2006). This can be a challenge for ESL learners, as they may need to make connections between their language proficiency and the research practices of their discipline, such as comprehending research questions, research methods, and the structure of argumentation (Anderson, 2003; Li, 2017).

AI discovery and summarization tools, like Connected Papers, Consensus, Scholarcy, and SciSpace, are at the nexus of academic reading and research literacy. Connected Papers creates a visual map of a seed paper based on citations, to help users find related and foundational work; Consensus is a semantic search engine that aggregates

evidence from peer-reviewed studies and reports the consensus level among them; and SciSpace integrates a large paper index with conversational explanation features for dense methodology and results sections. These tools are intended to be used together to enable researchers to shift from one text to a whole scholarly conversation, thereby alleviating the cognitive burden of navigating large volumes of texts (Luckin, 2018; Selwyn, 2022). This type of tool can facilitate the very shift from single-text comprehension to research-literacy engagement with a field that this study aims to support, but only when explicitly taught by instructors, who must also teach critical AI literacy skills: verifying AI-generated summaries against original texts, evaluating source credibility, and recognizing simplifications or omissions (Manzoor et al., 2025).

2.3. Contribution of the Present Study

While the literature on AI and ESL reading is growing rapidly, there are three salient gaps. First, most empirical studies are conducted on general reading or writing outcomes instead of the entire research-literacy process from literature discovery, critical reading, synthesis, to argumentation (Qi et al., 2025). Second, there are relatively few studies that employ mixed methods designs that integrate quantitative reading measures with qualitative understanding of students' autonomy, strategy use, and perceptions of AI (Jeon, 2025). Third, the existing evidence of AI-enhanced reading is largely from the general language-teaching or K-12 settings, which requires further research in the context of university-level ESL academic-reading courses (Guo et al., 2025).

The present study aims to fill these gaps by creating an eight-week, AI-enhanced academic-reading intervention for ESL university students that combines Connected Papers, Consensus, Scholarcy, and SciSpace in a scaffolded task sequence and by employing an explanatory sequential mixed-methods design to investigate changes in autonomy and research literacy. It does so by providing classroom-ready task designs and empirical evidence to support the shift from ad hoc to systematic, autonomy-oriented academic reading instruction.

3. Methodology

3.1. Research Design

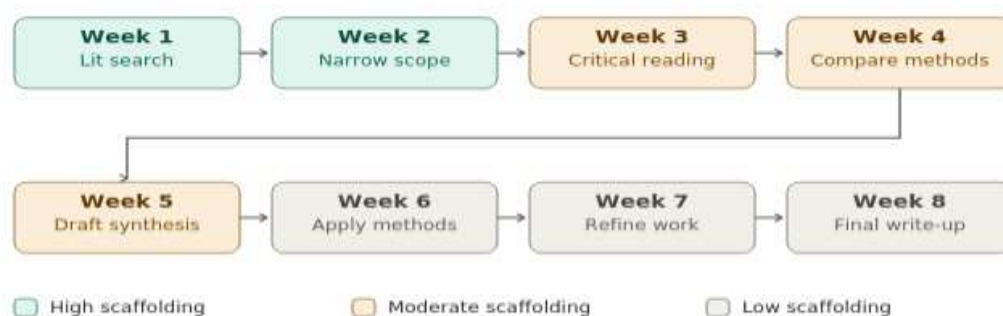
The study is explanatory sequential mixed methods design, where quantitative data is collected first and then followed by qualitative data to explain and enrich the quantitative data. During Phase 1, students took a pre-test and post-test in academic reading and a learner-autonomy questionnaire at both pre-test and post-test.

For Phase 2, the semi-structured interviews, and classroom observations were analyzed thematically to examine students' experiences and understandings of AI-supported reading and research-literacy practices. The eight-week intervention served as the main treatment and data were gathered pre- and post-treatment to monitor development over time.

3.2. Participants

The study was carried out in a public university in a Pakistan where English is the medium of instruction for many degree courses. The sample comprised 64 ESL undergraduate and postgraduate students aged between 19 and 27 years ($M = 21.5$, $SD = 2.1$) with 38 female and 26 male students. The students were all non-native speakers of English and proficiency was measured using a diagnostic placement test which contained a reading comprehension section based on a standard academic reading test, ranging from upper-intermediate to advanced level (CEFR B2–C1) as is typical of university level. Ethical approval was granted from the institution and informed consent was obtained from all participants before they participated.

3.3. Intervention



The eight-week intervention was integrated into a semester-long academic reading course. Two AI tools were introduced each week, gradually moving from literature discovery to more critical reading and synthesis, and were demonstrated interactively, practiced and problem solved collaboratively.

Weeks 1-2 (Connected Papers for literature discovery): Students created topic maps from seed papers in their disciplines, and then chose 5-10 papers to complete an annotated-bibliography exercise, practicing the skills of determining relevance, novelty, and contribution to a research question. One of the activities involved comparing Connected Papers maps to the ‘gold-standard’ bibliographies created by the instructor to discuss the algorithm's prioritization of some studies over others.

Weeks 3-4 (Consensus for evidence-oriented questions): Students restated short research questions in their own discipline (e.g., ‘Does AI enhance reading comprehension?’) and used Consensus to find and summarize evidence-based claims, then compared the results to original abstracts and full texts to identify discrepancies and omissions. Small groups also tried to ‘reverse-engineer’ an argument from the AI-generated summary of an original article.

Weeks 5-6 (Scholarcy for critical reading and summarization): Students uploaded selected articles to Scholarcy and then used the auto-generated summaries to guide them

in creating reading logs that included identifying the research question, methods, and main findings; highlighting strengths and limitations; and relating the article to other articles in their bibliography. Feedback from the instructor highlighted the need to use AI-generated content as a foundation and not copy and paste it.

Weeks 7–8 (SciSpace for tackling technical sections): Students used full-text PDFs in SciSpace, with emphasis on the methodology and results sections. They created annotated notes using the explanation and summarization tools, which they used to write a mini-literature review that translated technical language and statistics into more accessible language, and then used these notes to write a mini-literature review that synthesized at least three articles, incorporating AI-generated explanations with their own critical commentary.

At the end, Instructors highlighted the importance of critical AI literacy, including verifying AI-generated content with the original text, challenging algorithmic suggestions, and considering when human judgment is required. Scaffolding was phased out and students were supported to become more independent in their AI-supported reading and writing.

3.4. Data Collection Instruments

Three instruments were used to gather quantitative data. A pre–post academic reading test (40 items: 30 multiple-choice, 10 short-answer) measured comprehension, main-idea identification, inference, and vocabulary-in-context in authentic academic texts, and was pilot tested with a separate group to ensure reliability and validity. The students' self-reported autonomy was measured using a 25-item Likert scale learner autonomy questionnaire adapted from existing autonomy scales (Cronbach's $\alpha \approx 0.82$). Students' final mini-literature reviews were assessed using a rubric-based research-literacy checklist that included items for evidence of research-literacy practices (clear research question, logical organization, citation accuracy, critical evaluation of sources).

Qualitative data were gathered by having students complete weekly reflective journal entries describing how they used the tools, challenges they faced, and their perceptions of autonomy and understanding, conducting semi-structured exit interviews with 15 purposively selected students (20–30 minutes each), and observing students' interactions with the tools, peer discussion, and instructor scaffolding, as well as taking field notes.

4. Data Analysis

Data were analyzed using SPSS (Version 28) for quantitative data. Changes in reading and autonomy scores from pre-test to post-test were analyzed using paired-samples t-tests, Cohen's *d* was calculated to determine the practical significance, and research-literacy checklist scores were analyzed descriptively. Thematic analysis (Braun and Clarke, 2006) was employed to analyse the qualitative data from the journals and

interviews, with initial coding done inductively and themes and subthemes refined iteratively, NVivo was used to manage codes and ensure consistency across interpretations, and classroom observation notes were used to triangulate and contextualize themes and subthemes from the interviews and journals.

5. Results

5.1. Academic Reading Performance

Measure	Pre-test (M, SD)	Post-test (M, SD)	Change (Post–Pre)	Statistical Significance / Effect Size
Overall score	62.4 (9.3)	76.1 (8.7)	+13.7	$p < .001$; $d \approx 1.48$ (medium-to-large)
Inference tasks	58.1 (10.2)	74.3 (9.1)	+16.2	Larger gains than in detail items
Main-idea tasks	60.8 (9.7)	77.5 (8.9)	+16.7	Strongest improvement domain

The academic reading test showed a medium to large effect ($d \approx 1.48$) with students' scores significantly higher at post-test ($M = 76.1$, $SD = 8.7$) than at pre-test ($M = 62.4$, $SD = 9.3$). The improvements were most significant in tasks involving inference and main idea, indicating that the AI tools for navigation and summarization facilitated students' understanding of the overall structure and logic of the texts rather than just the details.

5.2. Learner Autonomy

Autonomy dimension	Pre-test (M, SD)	Post-test (M, SD)	Change (Post–Pre)	Statistical result
Overall autonomy	3.20 (0.58)	4.12 (0.49)	+0.92	$t(63) = 6.42$, $p < .001$
1. Set reading goals and allocate time effectively	3.05 (0.61)	4.08 (0.53)	+1.03	Large increase, highly significant
2. Select appropriate texts using AI overviews	2.97 (0.64)	4.10 (0.52)	+1.13	Strongest growth area
3. Discard irrelevant texts using AI overviews	2.88 (0.66)	4.05 (0.55)	+1.17	Marked improvement
4. Monitor comprehension and switch strategies	3.12 (0.60)	4.15 (0.51)	+1.03	Noticeable gains in self-regulation

There was a significant increase in overall autonomy from pre- to post-intervention, $t(63) = 6.42$, $p < .001$. The effect of the intervention on autonomy was more focused on selecting and discarding sources with AI-generated overviews, with the largest gains in this area, suggesting that the intervention did not have a consistent impact across all dimensions of autonomy.

5.3. Qualitative Analysis

Thematic analysis of the journals, interviews and observation notes, using the six phases of Braun and Clarke (2006), identified four main themes, each with two sub-themes that reflect the way the pattern evolved or changed within the cohort. Table 3 is a summary of the thematic structure prior to the discussion of each theme.

Main theme	Sub-themes	Primary data sources
AI as a scaffold, not a shortcut	(a) Early over-reliance on AI summaries; (b) Shift toward a preview–read–verify cycle	Journals (weekly), interviews
Emergence of autonomous research practices	(a) Reframing self as researcher rather than reader; (b) Justifying and defending source choices	Interviews, mini-literature reviews
Development of critical AI literacy	(a) Recognizing simplification and omission in AI outputs; (b) Cross-checking and comparing tools	Journals, observation notes
Collaborative and reflective learning	(a) Peer negotiation of tool-task fit; (b) Metacognitive articulation of personal strategy	Observation notes, journals

5.4. AI as a Scaffold, Not a Shortcut

During the first few weeks, journal entries and observation notes tended to focus on over-reliance, as students often used the initial AI-generated summary they were given as a final product, especially when using Scholarcy's auto-summaries and Consensus' evidence statements. The most common turning point mentioned in subsequent journal entries was the instructor prompts asking students to compare the AI summary with the original abstract before they write their reading log. By Weeks 5–8, the predominant pattern became one of preview–read–verify, with students using the AI-generated text to guide them through the main claim of a text, reading the text in full, and then returning to the AI tool to verify or challenge their reading. The progression indicates that the risk of scaffold-to-shortcut is not inherent, but is malleable and can be addressed through task design by incorporating a deliberate verification step.

5.5. The Development of Independent Research Practices

A second pattern was a change in students' own description of their role in relation to a text. Early journal entries were often written in a single-text, comprehension-oriented way (e.g., 'understanding the article', 'finishing the reading') while entries from Weeks 5–8 were more likely to be written in terms of the field level (e.g., comparing several studies, deciding which findings to include, deciding which sources 'belonged' in their annotated bibliography or mini-literature review). This reframing was most evident in the annotated-bibliography and mini-literature-review assignments, in which students were repeatedly asked to explain why a particular source was included or excluded, rather than

just summarizing it. This justification requirement was more likely to be linked to students feeling more like an active researcher than a passive reader than the use of the AI tools themselves, as revealed in the interview data, which aligns with the idea that autonomy gains are more likely to be linked to how the tools are used rather than the tools themselves (Benson, 2011; Holmes & Littlejohn, 2024).

5.6. Development of Critical AI Literacy

Students' journal entries and teacher observation notes over the weeks revealed a progressive development of specific, tool-related critiques, not general statements that 'AI can be wrong'. Some of the common findings were that Connected Papers' similarity maps sometimes highlighted more tangential papers that were cited more often, rather than the more relevant ones, that Consensus' evidence summaries sometimes ignored a study's limitations, and that Scholarcy's auto-summaries sometimes ignored methodological limitations of a paper. Students were more likely to follow up these observations with concrete verification strategies, such as rereading a flagged section of the original PDF, comparing the results of two tools on the same question, or pointing out a discrepancy to the instructor during class discussion, than to just note the limitation and proceed. This progression of more specific, tool-specific criticism aligns with the notion that critical AI literacy can be cultivated through repeated, guided exposure to AI tools, as suggested by reviews that emphasize the need for multiple orientations to foster this skill.

5.7. Collaborative and Reflective Learning

The collaborative problem-solving sessions revealed a consistent negotiation among peers about which tool would be most appropriate for a particular purpose, such as deciding to start a new topic with Connected Papers or Consensus, and a general consensus that Connected Papers would be used for a broad orientation and Consensus for a narrowly framed question. This tool-task matching seemed to have been a social process, rather than just a teaching process, as it was accomplished by trial and comparison within the group. Reflective journals also became more metacognitive specific over the 8 weeks, with early entries generally describing the use of the tool in general terms ('I used SciSpace to help me'), and later entries naming a specific strategy and why it was used (e.g., using the explanation feature of SciSpace only after an initial independent reading attempt). Overall, the findings from the collaborative and reflective data indicate that the intervention's success in fostering autonomy and critical AI literacy was as much a result of the collaborative and reflective nature of the data as it was of the tools themselves, further supporting the argument that gains in autonomy and critical AI literacy are dependent on pedagogical scaffolding rather than automatic.

6. Discussion

6.1. Implications for Academic Reading Instruction

The quantitative improvements in reading scores, along with qualitative evidence of deeper engagement with texts, indicate that AI tools for discovery and summarization can significantly boost ESL students' academic reading efficiency when integrated into a structured task sequence. These tools seemed to facilitate students' comprehension of literature maps and evidence landscapes, thereby enabling them to go beyond the comprehension of a single text to a more comprehensive understanding of scholarly debates, which aligns with the results of other studies that AI-based reading tools are best used in teacher-led, rather than unstructured, activity.

The scaffolded tasks prompted students to use AI in a systematic reading cycle (preview–read–analyze–summarize–cite), consistent with models of self-regulated reading instruction. The substantial gains in autonomy scores, which were largely in the area of resource selection and not across all dimensions, suggest that students were not merely relying on AI but learning new ways to assess and filter resources, a trend that aligns with recent findings that AI facilitation can lead to real autonomy gains, but not when used freely, and that it is scaffolded

6.2. Autonomy and Research Literacy

The results suggest that AI can be a tool to support ESL learners as emerging researchers, but only when the use of AI is explicitly taught in terms of research literacy and critical AI literacy. Students' increasing skills in designing and controlling the process of literature discovery, critically assessing AI-generated summaries, and justifying their selection of sources indicate a transition from passive reading to research-oriented reading. This has implications for how instructors design their syllabus: they can incorporate Connected Papers, Consensus, Scholarcy, and SciSpace into a structured reading and writing activity, gradually decreasing the scaffolding as students become more confident, and use conditional findings in the broader literature (e.g., that the benefits of AI for self-regulation depend on the length of the intervention and the design of the task) as a warning against assuming that such benefits will occur automatically (Jeon, 2025; Manzoor et al., 2025).

7. Limitations

There are a number of caveats to be noted. The sample size was small and the sample was from a single institutional setting, which reduces the generalizability of the findings. The intervention was relatively brief (8 weeks), and the sustainability of the acquired reading habits and autonomy is yet to be evaluated. The lack of a non-AI comparison group makes it difficult to conclude that the observed gains are due to the AI tools and not to the structured task design or to the increased reading practice more broadly; future research should incorporate a control condition to separate these effects.

8. Conclusion

This study shows that a well-designed, AI-integrated intervention can positively impact the academic reading achievement and learner autonomy of ESL university students. Incorporating Connected Papers, Consensus, Scholarcy, and SciSpace into scaffolded tasks enables instructors to guide students through intricate scholarly texts, identify relevant literature, and cultivate critical AI literacy. The mixed-methods results suggest that students not only read more effectively, but also read more autonomously, and that they see themselves as active participants in research conversations, rather than passive consumers of information. The findings suggest that further research is needed to investigate the potential for adapting specific AI tools to varying levels of proficiency, as well as to explore the long-term retention of the intervention, the impact of different combinations of AI tools, and the transfer of the intervention to other academic writing and research-design skills.

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