

**THE DEVELOPMENT OF A GUIDELINE FOR GENERATIVE AI-ENABLED
COGNITIVE OFFLOAD INSTRUCTION TO ENHANCE CRITICAL THINKING IN
WRITING ENGLISH ESSAYS**

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ABSTRACT

The study explores the use of Generative AI for cognitive offloading in English essay writing to promote inclusive, quality education. It aims to investigate the implementation of cognitive offload instruction via Generative AI to enhance critical thinking and to establish guidelines for educators. Using a quasi-experimental design, the research compares Generative AI tool-using Intervention Groups with traditional method-using Control Groups among 1,050 first-year English majors from four colleges, with 240 selected via purposive sampling. Critical thinking is rigorously evaluated using the Analytical Critical Thinking Scoring Rubric (ACTSR), with comprehensive pre-test and post-test assessments. This evaluation framework assesses key dimensions of critical thinking, including comprehension, interpretation, integration, inference, and reflective insight. Additionally, the study integrates a qualitative analysis of students' perceptions through the innovative use of Word Clouds, which distill thematic insights from discussion forums. This qualitative aspect highlights the subjective experiences and perceived benefits of Generative AI-enabled instruction in fostering critical thinking and writing skills. Results reveal that Intervention Groups, exposed to Generative AI-enabled cognitive offloading, consistently outperform Control Groups in critical thinking development, as evidenced by statistically significant improvements in post-test ACTSR scores. Additionally, the students' feedback, analyzed qualitatively, unanimously underscores the positive impact of Generative AI instruction. They commended the approach for its interactive nature, support in skill development, and the transferability of enhanced critical thinking and writing skills to various academic and

real-life contexts. The findings provide educational leaders and policymakers with evidence-based perspectives on integrating Generative AI technology to enrich educational environments and promote critical thinking across disciplines.

KEY WORDS: Generative AI, Cognitive Offload, Critical Thinking, Essay Writing

Introduction

In the realm of education, the insights generated from this study hold immense value. They contribute significantly to the overall improvement of education, specifically enhancing critical thinking in writing English essays. By leveraging the Generative AI-enabled cognitive offload instruction approach, this research empowers college students, instructors, and educational administrators. It offers practical solutions that foster the development of high-quality critical thinking skills in English essay writing. The potential impact of this study is far-reaching, as it equips students with the necessary tools to excel in their academic pursuits and prepares them for future careers. Furthermore, it enables instructors to refine their teaching methods and promotes the cultivation of critical thinking across disciplines. Educational administrators can leverage the outcomes of this research to inform educational policies that support the advancement of critical thinking skills among students. This study sets the stage for a transformative journey, where education reaches new heights through the effective integration of Generative AI-enabled cognitive offload instruction approach. Generative AI has gained significant attention in education, because they can provide instant and personalized feedback, engage students in interactive conversations, and offer access to a vast amount of information. However, Generative AIs in education, especially in English-essay writing instruction, face much challenges, for example, how to guide students to critically engage with the information provided by Generative AIs and how to ethically utilize Generative AIs in writing English essays. In a word, one of the primary problems in this field is the effective utilization of Generative AI to enhance critical thinking skills in writing English essays (Miao & Holmes, 2021; United Nations, 2023).

While various methods and approaches have been proposed to enhance students' critical thinking in writing essays, conducting this research presents an alternative and promising avenue. This research aims to develop the guideline for the Generative AI-enabled cognitive offload instruction approach to enhance critical thinking in writing English essays, as it offers unique insights and potential solutions to existing problems. By examining the effectiveness of the Generative AI-enabled cognitive offload instruction approach in improving critical thinking skills in the specific context of writing English essays, a deeper understanding of the effective instruction approach for significant improvements in students' critical thinking skills in writing English essays will be gained. The implications of this research extend beyond its immediate scope. Innovation is a key driver of progress, and by addressing the identified problems, this research can foster innovation within the domains of the education industry, Generative AI development, writing assistant applications development, etc. Moreover, the implications for educational administration innovation and humankind advancement are significant. Firstly, the findings of this research can help educational administrators recognize the value of cognitive offloading and incorporating

Generative AI technology into instruction, so administrators can create an environment that fosters critical thinking learning among students. Secondly, this research can contribute to the advancement of curriculum development. By emphasizing critical thinking skills as a core competency, educational institutions can revise and update their curricula to include instructional strategies and activities that facilitate the development of critical thinking skills (Adhikari, 2023; Kasneci et al., 2023; Sabzalieva & Valentini, 2023; Stepanechko & Kozub, 2023; Tlili et al., 2023) Considering the magnitude of the existing problems and the potential impact of this research, it is crucial to propose a comprehensive investigation into the potential benefits, challenges, and implications of using Generative AI technology as an instructional tool to support and develop students' critical thinking abilities in the specific domain of essay writing benefiting from the resources and collaborative opportunities available. Through rigorous data collection and analysis, the researcher seeks to provide empirical evidence on the benefits and challenges of this instructional approach. Ultimately, this research endeavors to advance the understanding and application of the Generative AI-enabled cognitive offload instruction approach to enhance critical thinking, paving the way for more effective educational practices and even for the broader field.

Research Objectives

1. To design a guideline for Generative AI-enabled cognitive offload instruction.
2. To refine the designed guideline for Generative AI-enabled cognitive offload instruction.
3. To implement and assess the impact of the refined guideline for Generative AI-enabled cognitive offload instruction on students' critical thinking abilities.
4. To examine the students' perceptions of the Generative AI-enabled cognitive offload instruction and its effectiveness in improving their critical thinking skills in writing English essays.

Research Methodology

The guideline for Generative AI-enabled cognitive offload instruction was designed to be a specific instructional method or intervention that was implemented and manipulated to investigate its impact on critical thinking skills in writing English essays. And, the "Skywork" was a Generative AI which was used in the research to serve as a tool for implementing the cognitive offload instruction approach. It acted as an artificial intelligence-based assistant that engaged with students, helped them navigate through the writing process, and facilitated their development of critical thinking abilities. The IOC questionnaire was used to assess the congruence between the intended objectives of the initially developed Skywork lesson plan and the expert judgments of its content and relevance. It consisted of a series of items or statements related to specific objectives and criteria, and experts were asked to rate the extent to which they perceived each item to be congruent with the intended objectives. This feedback regarding the quality and effectiveness of the lesson plan provided valuable insights into the strengths and weaknesses of Skywork lesson plan, helping the researcher refine and improve its design. After the IOC, modifications to the

initially developed lesson plan were made based on the feedback from the experts, and the revised Skywork lesson plan was used in the subsequent stages of the research.

After that, a group was created on an instant messaging application (Wechat) to hold a discussion with all IG students. The set of questions or prompts used in the instant messaging group discussion was the research instrument to guide the discussion and elicit specific information from the participants. The set of questions or prompts, in this case, helped collect qualitative data from the IGs to provide valuable insights into the effectiveness of Skywork lesson plan in enhancing critical thinking skills. The researcher helped to guide the discussion and ensured that all students had the opportunity to participate and share their thoughts by answering some open-ended questions. The students who actively participated in the discussion were offered incentives or rewards in order to encourage their participation. After the discussions had concluded, the researcher used Word Clouds to identify common themes and patterns in the data to understand the different perspectives and opinions shared by the students.

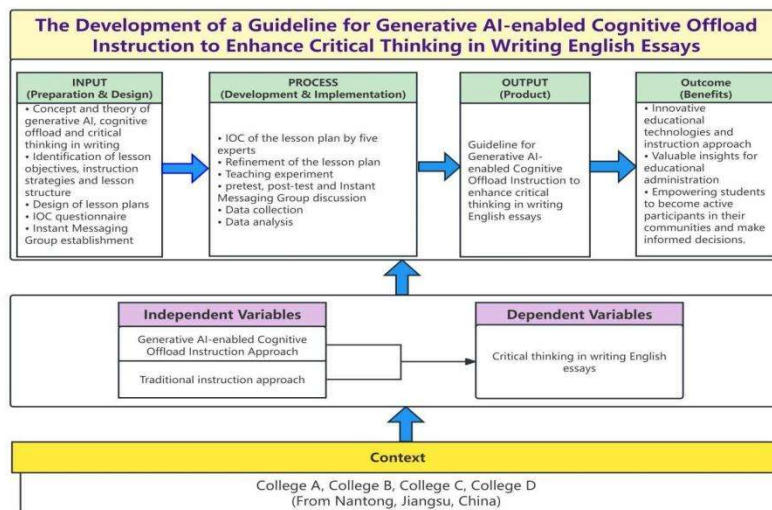


Figure 1 Conceptual framework of the research

Data Analysis

The data analysis of the research incorporated quantitative and qualitative methods to evaluate the impact of a Generative AI-enabled cognitive offload instruction on enhancing critical thinking skills in English essay writing among freshmen English majors. The study spanned across four colleges with a total population of 1,050 students, out of which 240 students (120 in the intervention group (IG) and 120 in the control group (CG)) were sampled for the experiment. Quantitative measures included the use of the Analytical Critical Thinking Scoring Rubric (ACTSR) for pre-test and post-test evaluations, focusing on critical thinking facets such as comprehension, interpretation, integration, inference, and reflective insight. Analysis through SPSS 26.0 yielded descriptive and inferential statistics to ascertain significant differences in test scores. In tandem, qualitative insights were gleaned from Word Clouds representing the frequency of terms used in students' discussion forum responses, offering a nuanced understanding of their perceptions of the Generative AI's role in the essay writing process.

Table 1 The population and sample of the research

The selected colleges	Population	Sample	
		IG	CG
College A	270	30	30
College B	200	25	25
College C	280	35	35
College D	300	30	30
Total	1,050	120	120

Research Results

1. *Designing a guideline for Generative AI-enabled cognitive offload instruction*

This framework was informed by existing literature, and expert consultations, making it both empirically valid and practically implementable. The Generative AI-enabled cognitive offload instruction approach, which involved the utilization of a Generative AI as a cognitive support tool. Therefore the “Skywork” was a Generative AI which was used in the research. It acted as an artificial intelligence-based assistant that helped them navigate through the writing process, and facilitated development of critical thinking abilities and provided clear instructions about how to engage with Skywork and how students should respond to them. So the research aimed to provide a standardized and replicable instructional framework that could be evaluated for its impact on students’ critical thinking abilities. Researcher needed to study information about how to use Generative AIs as tools to develop such skills of students and choose methods to teach how to use Generative AIs so that students can understand and use them correctly. Generative AIs are able to generate summary text as well as detect grammatical errors to make written content easier to understand and help students develop research skills by providing information on the topic and introducing them to new research topics, this allows them to gain better understanding and assessment of the topic. The lesson plan served as a roadmap for teachers to ensure consistency in the implementation of the Cognitive Offload Instruction Approach to provide a standardized teaching framework through which impacts on cognitive abilities can be assessed student’s critical thinking skills. So that researcher designed the guideline by following objective learning, introduction strategies, material for examination and use suitable experimental design for sample.

2. *Refining the designed guideline for Generative AI-enabled cognitive offload instruction*

This refinement process was not just an academic exercise but had direct, measurable impacts on the effectiveness of the instructional method, thereby fulfilling the objective by using Index of item objective congruence (IOC) for checking reliability of questionnaire to assess the congruence between the intended objectives of the initially designed guideline and the expert judgments of its content. Finally, modifications involved revising the learning objectives, adding, or removing activities, or modifying the lesson structure, etc. The questionnaire was shared with the selected experts, along with clear instructions on how to complete it. By comparing the experts’ ratings with predefined criteria, the researcher calculated item objective congruence for each item in the

questionnaire feedback from experts to help identify strengths and areas that need improvement and considered experts' comments and suggestions to refine and enhance the instructional design of the lesson plan, potentially involving revisions to learning objectives, lesson structure and activities.

3. Implementing and assessing the impact of the refined guideline on students' critical thinking abilities:

The impact on students' critical thinking abilities was assessed through both qualitative and quantitative measures. The data collected substantiated the positive impact, indicating not just an improvement in scores but a tangible enhancement in the quality of critical thinking exhibited by students. The results of the study strongly support the effectiveness of the refined guideline for Generative AI-enabled cognitive offload instruction in enhancing students' critical thinking abilities. The implementation of this guideline across the four colleges yielded significant quantitative improvements, as evidenced by the post-test scores in critical thinking skills. These scores were consistently higher in the intervention groups compared to the control groups, with statistical significance observed across the five dimensions of critical thinking.

Table 2 Student's critical thinking scores pre-test average score and standard deviation from the Intervention Groups and the Control Groups, and the independent t-test of the average pretest scores

Pretest Scores		IGs (n=120) $\bar{X} \pm SD$	CGs (n=120) $\bar{X} \pm SD$	t-value	p-value
1.comprehension analytical insight	with	2.95 ± 0.58	2.74 ± 0.67	2.59	0.01**
2.interpretation critical judgment	with	2.88 ± 0.7	2.81 ± 0.66	0.85	0.40
3.integration with practical application		2.98 ± 0.72	2.79 ± 0.65	2.17	0.03*
4.inference with problem-solving		3.00 ± 0.79	2.86 ± 0.69	1.48	0.14
5.reflective insight argumentation	with	2.88 ± 0.85	2.83 ± 0.67	0.42	0.67
Total		14.69 ± 1.21	14.03 ± 1.33	4.01	0.000** *

Note: P>0.05 = None significant (NS), P<0.05 =significant different (*), P<0.01 = highly significant different (**), P<0.0009 = Very high significant different (***)

Table 2 illustrates the Pretest Average Score of Students' Critical Thinking Scores, Categorized by Topics. Even though the p-values associated with these comparisons, such as P=0.000 for

overall scores, $P=0.01$ for comprehension with analytical insight, and $P=0.03$ for integration with practical application, do show statistical significance, it's very crucial to note that the actual differences in mean scores are relatively small. The average score of the total scores of the IGs surpassed that of the CGs by a marginal 0.66 points. In a similar vein, concerning comprehension with analytical insight, the average score of the IGs exceeding the CGs by merely 0.21 points. Additionally, in the realm of integration with practical application, there was a marginal 0.19-point difference in average scores. This suggests that, while there might be some statistically detectable distinctions, these may not be practically significant in terms of educational or cognitive impact. Furthermore, in critical thinking aspects like interpretation with critical judgment, inference with problem-solving, and reflective insight with argumentation, no significant differences in mean scores were observed between the groups.

Table 3 Student's critical thinking scores post-test average score and standard deviation from the Intervention Groups and the Control Groups, and the independent t-test of the average post-test scores and the gain scores

Post-test Scores		IGs (n=120) $\bar{X} \pm SD$	CGs (n=120) $\bar{X} \pm SD$	t-value	p-value
1.comprehension analytical insight	with	3.74 ± 0.44	3.03 ± 0.63	10.24	0.000***
2.interpretation critical judgment	with	3.66 ± 0.48	3.1 ± 0.64	7.66	0.000***
3.integration practical application	with	3.61 ± 0.49	3.08 ± 0.66	7.02	0.000***
4.inference problem-solving	with	3.67 ± 0.47	3.06 ± 0.66	8.17	0.000***
5.reflective insight argumentation	with	3.68 ± 0.47	3.03 ± 0.59	8.17	0.000***
Total		18.36 ± 1.11	15.3 ± 1.36	19.13	0.000***
Gain Score		3.67 ± 1.13	1.27 ± 1.26	15.60	0.000***

Note: $P>0.05$ = None significant (NS), $P<0.05$ =significant different (*), $P<0.01$ = highly significant different (**), $P<0.0009$ = Very high significant different (***)

Table 3 shows the students' critical thinking scores post-test average score categorized by the five dimensions. Overall ($P=0.000$), the IGs demonstrated a significantly higher mean score than the CGs at the 0.01 significance level, with a substantial gap of 3.06 points in total mean scores (compared to a mere 0.66-point difference in the pretest). Similarly, comprehension with analytical insight ($p=0.000$), interpretation with critical judgment ($p=0.000$), integration with practical application ($p=0.000$), inference with problemsolving ($p=0.000$) and reflective insight with argumentation ($p=0.000$) show that the intervention group had a significantly higher mean

score than the control group at the 0.01 level. Moreover, from the gain score data, it is evident that the IGs' average score increased by 3.67 after the experiment, while the CGs' score only increased by 1.27.

Table 4 Student's critical thinking scores pre-test and pos-test average score and standard deviation from the Intervention Groups and the paired samples t-test of the average pre-test and post-test scores

Pretest and Post-test Score ($\bar{X} \pm SD$)			t-value	p-value
1.comprehension with analytical insight	Post-test	3.74±0.44	14.997	0.000***
	Pre-test	2.95±0.58		
2.interpretation with critical judgment	Post-test	3.66±0.48	11.675	0.000***
	Pre-test	2.88±0.70		
3.integration with practical application	Post-test	3.61±0.49	8.675	0.000***
	Pre-test	2.98±0.72		
4.inference with problem-solving	Post-test	3.67±0.47	11.662	0.000***
	Pre-test	3.00±0.79		
5.reflective insight with argumentation	Post-test	3.68±0.47	12.019	0.000***
	Pre-test	2.88±0.85		
Total	Post-test	18.36±1.11	35.697	0.000***
	Pre-test	14.69±1.21		

Note: P>0.05 = None significant (NS), P<0.05 =significant different (*), P<0.01 = highly significant different (**), P<0.0009 = Very high significant different (***)

Table 4 shows the student's critical thinking scores Pre-test and Post-test Average Score categorized by the five dimensions. Overall (P=0.000), the post-test average scores of the IGs were significantly higher than their pre-test average scores at the 0.01 significance level. Similarly, in specific domains such as comprehension with analytical insight (P=0.000), interpretation with critical judgment (P=0.000), integration with practical application (P=0.000), inference with problem-solving (P=0.000), and reflective insight with argumentation (P=0.000), each indicates that the post-test average scores of the IGs were significantly higher than their pretest average scores at the 0.01 significance level.

4. Examining the students' perceptions of the Generative AI-enabled cognitive offload instruction and its effectiveness:

Instant messaging group discussions were employed to capture student perceptions. The Word Clouds of feedback on the effectiveness of the Guideline for Generative AI-enabled Cognitive Offload Instruction Approach in week 4, the highest frequency words were: Skywork, Ability,

Feedback, Skills, Thinking, Evidence, Writing, Information, Arguments, Tool, Peers, and Perspectives, respectively. In week 9, the highest frequency words were: Skywork, Writing, Ability, Evidence, Arguments, Skills, Essays, Thinking, Number, and Feedback, respectively. Overall, in week 4 and 9, the highest frequency were: Skywork, Ability, Writing, Feedback, Evidence, Skills, Thinking, Arguments, Essays, and Peers, respectively. The feedback on the effectiveness of the Guideline for Generative AI-Enabled Cognitive Offload Instruction Approach in week 4 and 9 revealed significant positive impacts. In week 4, students highlighted how Skywork transformed their critical thinking and writing skills, offering a structured approach that improved the quality of their work. By week 9, students reported increased confidence in constructing well-organized arguments and effectively utilizing evidence. The feedback highlighted several key findings:

- (1) Impact on Critical Thinking and Writing Skills: Students' feedback unanimously indicated that Skywork has been transformative in enhancing their critical thinking and writing skills. It served as a structured pathway for brainstorming, organizing thoughts effectively, and improving the quality of written work. Students also appreciated its guidance throughout the essay-writing process, making them more systematic and analytical. Confidence in constructing well-organized arguments and using evidence effectively had also increased.
- (2) Effective Features of Skywork: Students found several features of Skywork beneficial, including its ability to generate relevant prompts and provide constructive feedback. These features encouraged deeper thinking, leading to higher-quality essays. The feedback mechanism helped students incrementally improve their writing, resulting in clearer and more persuasive arguments.
- (3) Use of Skywork in Developing Stronger Arguments: Skywork aided students in collecting and applying evidence to support their arguments, saving time in research and leading to more convincing essays. It ensured well-supported, evidence-based arguments, a crucial aspect in academic writing.
- (4) Promoting Critical Examination of Different Perspectives: Skywork effectively prompted students to explore counterarguments and alternative perspectives. It presented opposing viewpoints and encouraged critical thinking beyond initial opinions, fostering well-rounded thinking and writing.
- (5) Interactive Nature and Motivation: The interactive nature of Skywork motivated students in the writing process, serving as a "virtual study buddy." It kept students focused, alleviated common challenges, and reduced stress associated with essay writing.
- (6) Enhanced Analytical Skills: Skywork improved students' ability to analyze and evaluate information effectively. It broke down complex concepts, provided concise summaries of key points, and enhanced analytical competencies, making it easier to dissect complex information.
- (7) Impact on Essay Structuring and Organization: Skywork influenced how students approached structuring and organizing their essays. It encouraged logical and coherent outlines, visual aids, and smoother writing processes, focusing on content quality.

Conclusion

This research meticulously examined the effects of a Generative AI-enabled cognitive offload instruction approach, dubbed “Skywork,” on enhancing the critical thinking skills of English major freshmen in essay writing. It began by crafting a guideline informed by scholarly research and expert insights, establishing a replicable framework for AI integration in education. The guideline’s refinement process involved a systematic assessment using the Index of Item Objective Congruence (IOC), ensuring the educational content met pedagogical objectives and was responsive to expert critique. The practical application of this guideline revealed significant quantitative improvements in students’ critical thinking abilities, with the IGs outperforming the CGs. This outcome was substantiated by qualitative feedback, indicating not only enhanced score metrics but also a deeper engagement in critical thinking processes. Literature such as Lin & Chang (2020) and Yan (2023) supports these findings, highlighting the positive influence of Generative AI on writing and cognitive skills development. Moreover, the exploration of student perceptions revealed a resoundingly positive experience with the AI-enabled instruction. Participants noted marked improvements in their essay writing, credited to the AI’s assistance in argument development and grammatical accuracy, which resonates with the transformative educational implications found in studies like Goda et al. (2014). In essence, this research presents a compelling case for the Generative AI-enabled Cognitive Offload Instruction as an effective educational tool, demonstrating its capacity to significantly uplift students’ critical thinking and writing competencies through a novel AI-enabled pedagogical approach.

Recommendations

1. Recommendations for implementation

- (1) College Management Level: Focus on integrating the Guideline into the overall educational strategy. Ensure allocation of resources and administrative support for departmental and teacher-level implementation. This level oversees the macro-level adoption and adaptation of the Guideline.
- (2) Department Management Level: Adapt the Guideline to fit specific curricular needs. Coordinate with faculty to incorporate AI-enabled tools into teaching methods effectively. This level acts as a bridge, translating broad strategies into actionable teaching practices.
- (3) Teacher Management Level: Directly apply the Guideline in classroom settings. Use it to design lesson plans and assess student progress. Teachers are key in providing ground-level feedback for the Guideline’s refinement.
- (4) Collaborative Implementation: All levels must work in synergy. The attached model diagram illustrates the interconnected roles of each management level, ensuring a cohesive approach to enhancing critical thinking in English essay writing through AI-assisted instruction.

2. Recommendations for future study

- (1) Future studies should focus on analyzing students' behavioral patterns in utilizing Generative AI-Enabled Cognitive Offload tools. A methodological approach could involve the deployment of a structured multiple-choice questionnaire to collect data, followed by employing the Chi-square independence test for analytical purposes. The primary aim would be to investigate if the usage patterns of these tools vary based on factors such as gender, academic department, faculty, or college affiliation.
- (2) Further research is recommended to delve into how the frequency of Generative AI-Enabled Cognitive Offload tool usage in education correlates with demographic variables. This research could utilize logistic or multinomial regression analyses to predict the likelihood of different frequencies of usage. Essential demographic variables for consideration in this study would include gender, age, academic department, and other pertinent factors.
- (3) Future studies should also consider the direct application of the Generative AI-enabled Cognitive Offload Instruction Guideline in classroom settings. Emphasis should be on how teachers can use this guideline to design lesson plans and assess student progress. Furthermore, the role of teachers in providing essential feedback for the refinement of these guidelines is crucial. Research should also explore the effectiveness of collaborative implementation across various educational management levels to ensure a unified approach in enhancing critical thinking skills in English essay writing through AI-assisted instruction

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