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Perceptions of the generative AI-enabled cognitive offload instruction in English writing

Hui Hong, Poonsri Vate-U-Lan, Chantana Viriyavejakul
School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand

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ABSTRACT

This study examines the students' perceptions of the generative artificial intelligence (AI)-enabled cognitive offload instruction and its effectiveness in improving their critical thinking skills in writing English essays. This qualitative research collects data from 120 students through focus group discussions and is analyzed by Word Clouds to generate a visual representation of the word frequencies. The findings reveal that generative AI-enabled cognitive offload instruction had: i) an impact on critical thinking and writing skills; ii) effective features of Skywork, ability to generate relevant prompts and provide constructive feedback; iii) use of Skywork in developing stronger arguments; iv) promoting critical examination of different perspectives; v) interactive nature and motivation; vi) enhanced analytical skills; vii) impact on essay structuring and organization; viii) feedback and revision process; and ix) transferability of critical thinking skills. This study concludes that the highest frequency was Skywork, ability, writing, feedback, evidence, skills, thinking, arguments, essays, and peers. Students recommend in-depth explanations for complex topics, advanced tutorials, regular updates, collaboration features, advanced modules, and personalized learning paces to enhance Skyworks's integration into instruction.

Corresponding Author:

Poonsri Vate-U-Lan
School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang
Chalong Krung Alley, Lat Krabang, 10520 Bangkok, Thailand
Email: poonsri.va@kmitl.ac.th

1. INTRODUCTION

The current situation surrounding the development of the generative artificial intelligence (AI)-enabled cognitive offload instruction approach to enhance critical thinking is characterized by a range of regulations and plan strategies published by the United Nations. For instance, the United Nations sustainable development goals (SDGs), precisely goal 4: quality education, aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all [1]. Besides, United Nations Educational, Scientific and Cultural Organization (UNESCO) [2] is committed to supporting member states in harnessing the potential of AI to achieve the education 2030 agenda. The generative AI named "Skywork" is China's first dual hundred-billion-scale language model, sharing similar characteristics to ChatGPT's. It is a generative AI product developed by Kunglun Wanwei Technology [3], capable of meeting various needs such as writing essays, knowledge querying, code programming, logical reasoning, and mathematical calculations [4]. Skywork has powerful natural language processing (NLP) and intelligent interaction capabilities. It can be applied in various scenarios, such as intelligent question and answer or Q&A, chat interaction, and text generation. It has a rich knowledge base covering science, technology, culture, art, and history [5].

Skywork is a state-of-the-art generative AI model developed in China, notable for being the country's first dual 100-billion-scale language model. This model represents a significant leap in NLP, with its massive scale allowing it to handle complex language tasks with remarkable accuracy [6]. The “dual 100-billion-scale” refers to the model's vast number of parameters exceeding 200 billion, enabling it to generate human-like text and understand context with high precision. Skywork integrates advanced machine learning techniques and vast training datasets to perform various language-related tasks. Its architecture supports diverse applications, including text generation, translation, summarization, and question-answering. By leveraging its extensive parameterization, Skywork can produce coherent and contextually relevant outputs, making it a powerful tool in commercial and research settings [7]. Skywork can generate high-quality written content for blogs, articles, and marketing materials, assisting writers and content creators by providing drafts or inspiration. The model enhances translation accuracy and fluidity by understanding and translating text between multiple languages, including nuanced and idiomatic expressions. It can automate responses in customer service settings, providing instant and contextually appropriate answers to user inquiries, thereby improving service efficiency. Skywork supports educational applications by generating learning materials. Researchers can use Skywork to summarize academic papers, generate research hypotheses, or explore new ideas through its text-generation capabilities [8].

In December 2020, the “International Forum on AI and the Futures of Education: Developing Competencies for the AI Era” was co-organized by UNESCO, the Ministry of Education of the People's Republic of China, and the National Commission of the People's Republic of China for UNESCO. The forum shared policies and practices explicitly focusing on defining the competencies required in the AI era and strategies to prepare everyone to live and work with AI effectively. The forum also mentioned that critical thinking enables students to navigate the ambiguity and uncertainty of the future world, so AI should be embedded to promote the development of each student's critical thinking skills [2]. In addition, in April 2023, UNESCO published "ChatGPT and AI in higher education: quick start guide" to provide an overview of how ChatGPT works and explain how it can be used in higher education. However, despite these efforts, significant challenges and gaps still need to be addressed in our understanding of utilizing generative AI to effectively enhance critical thinking in writing English essays among foreign language learners [3].

According to Karthikeyan [8], Skywork currently faces some challenges: i) bias and fairness: like many large language models, Skywork may exhibit biases in the training data. This can lead to outputs that reflect or reinforce societal prejudices, impacting the fairness and inclusivity of its applications; ii) contextual understanding: despite its large scale, Skywork may struggle with deep contextual understanding or generate responses that lack nuance. This can be particularly challenging in complex or ambiguous scenarios; iii) data privacy: handling sensitive information in interactions with Skywork raises concerns about data privacy and security. Ensuring that user data is protected and used responsibly is crucial; vi) resource intensity: the large-scale model requires significant computational resources for training and deployment. This can lead to high operational costs and environmental impact due to energy consumption; and v) ethical use: the potential for misuse of generative AI, such as generating misleading information or deepfakes, poses ethical challenges. Ensuring responsible usage and implementing safeguards are critical. In conclusion, Skywork represents a significant advancement in generative AI, with its dual hundred-billion-scale architecture enabling powerful language capabilities. However, addressing challenges related to bias, contextual understanding, data privacy, resource intensity, and ethical use is essential for maximizing its benefits and ensuring responsible deployment.

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. 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. The expected outcomes of this research hold significant value from three perspectives: innovation, educational administration, and humankind advancement. From an innovation standpoint, the research outcome is a guideline for the generative AI-enabled cognitive offload instruction approach to enhance critical thinking in writing English essays. This can lead to the development of innovative educational technologies and approaches, advancing the field of technology integration in education. From an educational administration perspective, the research outcomes can provide valuable insights for curriculum design, instructional planning, and assessment strategies to improve the quality of education and foster student success. This can result in better educational outcomes and prepare students for the demands of the 21st-century workforce. From a humankind advancement perspective, by equipping students with critical thinking skills, the research can empower individuals to become active participants in their communities and make informed decisions. This can positively impact social, economic, and cultural development, fostering a more inclusive and progressive

society. Therefore, this study examines the students' perceptions of the generative AI-enabled cognitive offload instruction and its effectiveness in improving their critical thinking skills in writing English essays.

Critical thinking is a cognitive skill related to rational judgment, defined as "the educational cognate of rationality" [9]. It refers to using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems and assess the performance of oneself, other individuals, or organizations to make improvements or take corrective action [10]. Olivares *et al.* [11] also mentioned the components of critical thinking skills: reasoning, problem-solving, and decision-making. Critical thinking is reasonable and reflective thinking focused on deciding what to believe or do [12], which calls for a persistent effort to examine any belief or supposed form of knowledge in the light of the evidence that supports it and the further conclusions to which it tends. Moreover, Maiorana [13] stated that the purpose of critical thinking is to use questioning techniques to achieve understanding, evaluate viewpoints, and solve problems. Critical thinkers raise vital questions and problems, formulate them, gather and assess relevant information, use abstract ideas, think open-mindedly, and communicate effectively with others. Critical thinking is the ability to think clearly and rationally about what to do or believe. It includes the ability to engage in reflective and independent thinking. It also challenges an individual to use reflective, reasonable, rational thinking to gather, interpret, and evaluate information to derive a judgment.

Critical thinking is a cornerstone of effective essay writing, particularly in English, where clarity, argumentation, and analytical depth are paramount. It involves not just presenting information but engaging with it in a meaningful way, examining its validity, and constructing well-reasoned arguments. At its core, critical thinking in essay writing requires a rigorous evaluation of sources and evidence. Writers must question their sources' reliability, assess the information's credibility, and consider different perspectives before integrating them into their essays. This process ensures that arguments are not based on flawed or biased data but are grounded in well-supported evidence. Moreover, critical thinking involves the ability to synthesize information and present it coherently. Writers must organize their ideas logically, ensuring that each point builds upon the previous one in a structured manner. This requires an understanding of the material and the skill to connect ideas and arguments effectively, creating a compelling narrative that guides the reader through complex concepts. Additionally, critical thinking encourages self-reflection and revision. Writers must be willing to critique their arguments, identify weaknesses, and make necessary revisions. This reflective process is crucial for refining ideas and enhancing the essay's overall quality. By challenging their assumptions and considering alternative viewpoints, writers can produce more nuanced and persuasive arguments. Furthermore, practical critical thinking in essay writing involves clear and precise language. Writers must articulate their thoughts succinctly and avoid ambiguity, ensuring readers understand their arguments quickly. This clarity is essential for conveying complex ideas and engaging the audience. In conclusion, critical thinking is integral to writing high-quality English essays. It involves evaluating evidence, synthesizing information, self-reflection, and clear communication. By embracing these practices, writers can produce essays that are not only informative but also persuasive and insightful [14].

According to Dawson [15], cognitive offload refers to using external tools or strategies to reduce the mental effort required for complex tasks. In writing English essays, cognitive offload can significantly enhance productivity and writing quality by leveraging various aids and techniques to manage cognitive load more effectively. One common form of cognitive offload is writing aids such as outlines and mind maps. By organizing ideas and structuring arguments before drafting, writers can reduce the cognitive burden of remembering and arranging thoughts during writing. Outlines serve as a roadmap, guiding writers through the essay's structure and ensuring that key points are addressed systematically. On the other hand, mind maps visually represent relationships between concepts, helping writers to brainstorm and organize ideas more efficiently [16]. Additionally, digital tools play a critical role in cognitive offload. Grammar and spell-check software, such as Grammarly or Microsoft Word's built-in tools, help writers focus on content creation rather than mechanical errors. These tools provide real-time feedback, allowing writers to correct mistakes and refine their writing without diverting cognitive resources from higher-order tasks like argument development and analysis [17].

Cognitive offload also includes using reference management tools like Zotero or EndNote. These tools help organize and cite sources, reducing the mental effort in managing bibliographic information. By automating citation processes, writers can concentrate on constructing their arguments and integrating evidence effectively [18]. Moreover, delegating proofreading and editing tasks to peer reviewers or professional editors is another form of cognitive offload. By receiving external feedback, writers can gain new perspectives and identify areas for improvement they might overlook [19], [20]. In conclusion, cognitive offload in writing English essays involves employing external tools and strategies to manage mental effort and enhance writing efficiency. By using outlines, digital aids, reference management tools, and external feedback, writers can reduce cognitive load and focus on producing high-quality, well-organized essays.

2. RESEARCH METHOD

This research uses qualitative research methodology [21]. The participants are 120 students in the IG at Nantong Normal College, Nantong Health College of Jiangsu Province, Jiangsu Shipping College, and Jiangsu Vocational College of Business, China, instant messaging group discussions [22]. Frequencies of words to show the main themes or patterns that emerge from the students' responses: research tools are focus groups and questions in an instant messaging group discussion. The researcher will create a group on an instant messaging application (WeChat) to discuss with all intervention group students.

2.1. Data collection

Two instant messaging group discussions will be organized online (WeChat group) during the research period [23], one in week four and the other in week nine. To ensure it directional the researcher will design a set of specific questions in the discussions to encourage participants to engage deeply with the topics. After the discussions, the researcher will collect the participants' outputs or responses, which can provide subjective perspectives and valuable qualitative data to show the students' perceptions of the generative AI-enabled cognitive offload instruction approach and their experiences of using generative AI to offload them in writing English essays.

2.2. Data analysis

First, the researcher will collect the textual responses from the instant messaging group discussions, compile them into a single document, and ensure that the responses are free of any irrelevant or redundant information [24]. For example, the researcher will preprocess the text by removing stop words (commonly used words like "and," "the," and "is") and punctuation. The researcher will also stem the words to reduce them to their base form. Secondly, the researcher will use a Word Cloud generator tool named Word Clouds to represent the word frequencies visually. The size or color of each word in the Word Cloud reflects its frequency in the dataset. The more frequently a word is used, the larger or more prominent it appears in the Word Cloud [25]. Thirdly, the researcher will analyze and interpret the findings, discuss the main themes or patterns from the students' responses, highlight notable insights or trends, and relate them to the research objectives and questions. These can provide insights into the participants' perceptions, experiences, or opinions regarding the instructional approach [26]. Finally, the researcher will present the results of the qualitative analysis in the research report with tables, figures, and concise summaries. Meanwhile, the researcher should maintain the confidentiality and anonymity of the participants' responses throughout the analysis and reporting process [27].

3. RESULTS AND DISCUSSION

3.1. The students' perceptions of the generative AI-enabled cognitive offload instruction and its effectiveness

The researcher collected data about feedback from 120 student samples in the intervention group across four colleges regarding the effectiveness of the guideline for generative AI-enabled cognitive offload instruction approach in enhancing critical thinking in writing English essays. In the Words Cloud of feedback on the effectiveness of the guideline for generative AI-enabled cognitive offload instruction approach in week four, the highest frequency words were: Skywork, ability, feedback, skills, thinking, evidence, writing, information, arguments, tool, peers, and perspectives, respectively.

In week nine, the words with the highest frequency were Skywork, writing, ability, evidence, arguments, skills, essays, thinking, number, and feedback, respectively. In weeks four and nine, the highest frequency was 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 weeks four and nine revealed significant positive impacts. In week four, students highlighted how Skywork transformed their critical thinking and writing skills, offering a structured approach that improved the quality of their work. By week nine, students reported increased confidence in constructing well-organized arguments and effectively utilizing evidence.

- Impact on critical thinking and writing skills: students' feedback unanimously indicates that Skywork has enhanced their critical thinking and writing skills. It serves as a structured pathway for brainstorming, organizing thoughts effectively, and improving the quality of written work. Students also appreciate its guidance throughout the essay-writing process, making them more systematic and analytical. Confidence in constructing well-organized arguments and using evidence effectively has also increased.
- Effective features of Skywork: students find several features of Skywork beneficial, including its ability to generate relevant prompts and provide constructive feedback. These features encourage deeper

thinking, leading to higher-quality essays. The feedback mechanism helps students improve their writing incrementally, resulting in more precise and persuasive arguments.

- Use of Skywork in developing stronger arguments: Skywork aids students in collecting and applying evidence to support their arguments, saving time in research and leading to more convincing essays. It ensures well-supported, evidence-based arguments, a crucial aspect of academic writing.
- Promoting critical examination of different perspectives: Skywork effectively prompts students to explore counterarguments and alternative perspectives. It presents opposing viewpoints and encourages critical thinking beyond initial opinions, fostering well-rounded thinking and writing.
- Interactive nature and motivation: Skywork's interactive nature motivates students in the writing process, serving as a "virtual study buddy." It keeps students focused, alleviates common challenges, and reduces stress associated with essay writing.
- Enhanced analytical skills: Skywork improves students' ability to analyze and evaluate information effectively. It breaks down complex concepts, provides concise summaries of key points, and enhances analytical competencies, making it easier to dissect complex information.
- Impact on essay structuring and organization: Skywork influences how students approach structuring and organizing their essays. It encourages logical and coherent outlines, visual aids, and smoother writing processes, focusing on content quality.
- Feedback and revision process: Skywork plays a pivotal role in the revision process, pinpointing areas for improvement, enhancing the overall quality and readability of essays, and acting as a personal writing coach.
- Transferability of critical thinking skills: skills developed through Skywork are transferable to other academic areas and real-life situations. Students apply critical thinking to problem-solving in various subjects and improve their ability to analyze research papers and form evidence-based conclusions.
- Suggestions for improvement: students recommend more in-depth explanations for complex topics, advanced tutorials, regular updates, collaboration features, advanced modules, and personalized learning paces to enhance Skyworks's integration into instruction further.

Figure 1 displays a Word Cloud illustrating the most frequently mentioned words in feedback on the effectiveness of Skyworks during week four. Larger words indicate higher frequency, with prominent terms such as Skyworks, ability, feedback, skills, thinking, and evidence standing out. These words suggest that users frequently discussed how Skyworks enhanced specific abilities, including critical thinking, skill development, and providing useful feedback. Other significant terms, like writing, information, arguments, tool, peers, and perspectives, reflect users' emphasis on how the AI tool supports organized writing, argument construction, and peer collaboration. This visualization highlights key areas where Skyworks is perceived as beneficial for improving writing and analytical abilities.

Figure 2 presents a Word Cloud of the most frequently mentioned words in feedback on the effectiveness of Skyworks during week nine. Key terms like Skyworks, writing, ability, evidence, arguments, and skills are displayed prominently, reflecting their high frequency in student feedback. Compared to week 4, words such as essays, thinking, number, and feedback also appear with notable emphasis. This shift indicates that by week nine, students felt more confident in their ability to construct well-organized essays, effectively use evidence, and develop structured arguments. The prominence of these terms suggests that students increasingly recognized Skyworks's role in enhancing critical writing skills and analytical thinking. The visualization underscores the tool's effectiveness in building students' abilities to create cohesive, evidence-based arguments.

Figure 1. The Words Cloud of feedback on the effectiveness of Skyworks in week four

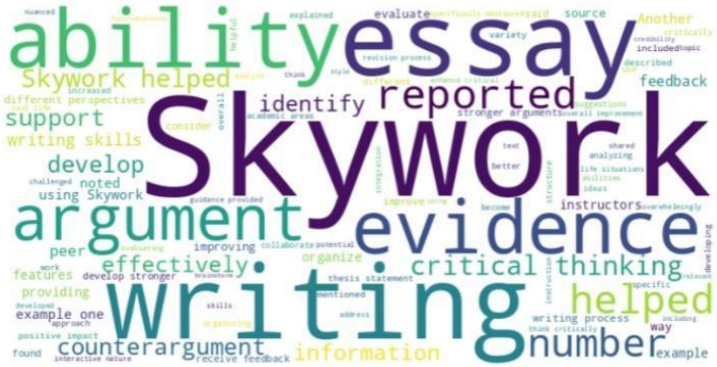

Figure 2. The Words Cloud of feedback on the effectiveness of Skyworks in week nine

3.2. Discussion

The subjective experiences of the students who engaged with the generative AI-enabled cognitive offload instruction and instant messaging group discussions were employed to capture student perceptions. The results were overwhelmingly positive, with students reporting an improvement in their ability to think critically, particularly in English essay writing. This improvement is attributed to the AI platform's capabilities, which not only assist students in developing stronger arguments and supporting them with evidence in their essays but also extend to helping them locate relevant research papers. Consequently, this made their essays more robust, ensuring their arguments were well-supported with credible evidence. The platform also addresses grammatical errors and suggests sentence structure modifications, enhancing their essays' overall quality and readability.

According to relevant research, the study by Goda *et al.* [28] support these findings, suggesting that generative AI can significantly improve students' critical thinking skills. It is worth noting that the positive student response underscores the transformative impact of AI-assisted learning on critical thinking and writing skills. Research by Suriano *et al.* [29] further supports this by demonstrating how AI tools reduce cognitive load, allowing students to engage more deeply in higher-order thinking, such as analysis and synthesis. This cognitive offload enables users to invest more mental energy in complex tasks, ultimately improving critical thinking. Interactive learning environments also play a crucial role in fostering engagement.

Bușu [30] emphasize the importance of AI tools, which generate relevant prompts and provide real-time feedback to facilitate metacognitive learning. Skywork's ability to offer constructive feedback mimics dynamic interactions in peer review, helping learners refine their arguments and structure. Moreover, it promotes the critical examination of diverse perspectives, aligning with Paul and Elder [31] emphasis on argumentation in developing robust analytical skills. The tool's interactivity also reinforces motivation and enhances the transferability of critical thinking skills. This aligns with Dweck and Yeager [32] research on growth mindset interventions, suggesting that AI systems can motivate learners through personalized feedback. Furthermore, Halpern [33] highlights that practicing analytical skills in diverse contexts enhances their transferability across domains. Skywork's ability to assist at multiple stages of writing, from brainstorming to revision, further strengthens this adaptability.

4. CONCLUSION

The study highlights the positive impact of generative AI-enabled cognitive offload on enhancing English writing and critical thinking skills. Users find these tools valuable for streamlining writing tasks, allowing more focus on idea generation, argument development, and revision. Features like prompt generation and feedback from tools like Skywork improve organization, argumentation, and engagement. This AI-enabled cognitive support fosters transferable analytical skills beyond writing. The study recommends a three-tiered approach to integrating AI in writing instruction: i) college management level: integrate guidelines into the educational strategy with resources and support; ii) department management level: adapt guidelines for curricula, coordinating AI tools with faculty; and iii) teacher level: apply guidelines in classrooms, designing lessons and assessments based on AI tools. A collaborative approach among all levels ensures effective implementation and enhancement of critical thinking in writing education.

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Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Hui Hong	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	
Poonsri Vate-U-Lan	✓	✓	✓					✓	✓	✓				
Chantana Viriyavejakul	✓			✓			✓			✓			✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

All experimental procedures conducted in this study were exempt from ethical approval by the four institutes that participated in this study. The research falls under the category of low-risk research, as it involves the use of records that contain only non-identifiable information. The study does not require ethical review due to the use of properly anonymized data where informed consent had already been secured.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author [PV], upon reasonable request.

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BIOGRAPHIES OF AUTHORS

Hui Hong is a student in program of doctor of science in Educational Administration Innovation for Humankind Advancement, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang in Thailand. Now she is doing research in the field of educational administration at Nantong Normal College, Jiangsu, China. She can be contacted by email: 63603167@kmitl.ac.th.

Poonsri Vate-U-Lan is a professor and program director of master of science industrial education in Educational Administration Innovation for Humankind Advancement at the International Office, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang in Thailand. She is an expert in research and development in education, technology, administration, artificial intelligence, and sustainable development goals. She can be contacted at email: poonsri.va@kmitl.ac.th.

Chantana Viriyavejakul is a professor at Faculty of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang in Thailand. Her expert is in educational technology. She can be contacted at email: chantana.vi@kmitl.ac.th.