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Enriching Learning Process with Generative AI: A Proposed Framework to Cultivate Critical Thinking in Higher Education using Chat GPT

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Abstract: - The emergence of large language models like ChatGPT, a Generative AI (GAI) tool has created excitement about their potential to enhance education, but also concerns about overreliance and lack of critical thinking. This study aims to develop and evaluate a conceptual framework named "AI-CRITIQUE" (AI-based Critical Reflection and Insightful Thought Unleashed for Education) for leveraging ChatGPT to promote critical thinking abilities in higher education settings. Our proposed framework provides structured guidance for focused questioning, gathering diverse perspectives, evaluating responses, synthesizing insights, and reflective learning to critically analyze and build upon AI output. An empirical study was conducted with 20 undergraduate students, who answered an open-ended question with and without ChatGPT. They utilized the proposed framework when using ChatGPT. Responses were analyzed using Lee's model of thinking levels. A survey also assessed student perceptions. When using the framework with ChatGPT, students' average thinking level significantly increased from recall (1.35) to rationalization (2.4). Survey results showed on average students felt AI helped substantially with idea generation (4.0/5.0) and critical analysis (4.2/5.0) compared to independent work. The study provides preliminary evidence that the proposed framework can effectively leverage ChatGPT's capabilities to enhance critical thinking. While further research is needed, this offers a promising novel approach for AI integration to augment human abilities and critical thinking.

Keywords: Generative AI, ChatGPT, Critical Thinking, Higher Education, Lee's Model

1. Introduction

Large language models (LLM) like ChatGPT have become popular, and their possible effects on education have generated a lot of debate. On the other hand, these tools show promising natural language abilities and present exciting new possibilities for enhancing educational settings [1,2]. However, concerns persist regarding overreliance on such systems, including negative impacts on critical thinking and academic integrity. This emphasizes the necessity of creating frameworks based on principles to direct the incorporation of AI systems into educational settings. Well-crafted frameworks can assist in utilizing AI's special powers to promote deeper thinking levels and encourage responsible use in line with educational goals.

Critical thinking refers to the cognitive ability to methodically review and interpret information in a logical manner, analyze underlying assumptions, evaluate the credibility of evidence, and ultimately reach well-founded and valid conclusions [3]. The exploration and development of the concept of critical thinking have been undertaken by multiple academic fields, such as philosophy, education, and psychology [4]. The ability to think critically is widely recognized and considered to be of utmost importance in the realm of education, as it holds a crucial role in promoting academic

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success and enabling the acquisition of vital skills for future professional endeavors [5]. The development of critical thinking abilities is widely recognized as an essential skill that education should promote in order to enhance students' achievements in academia and their careers. However, studies suggest that a substantial number of students exhibit a lack of proficiency in their ability to engage in critical thinking [6, 7], hence underscoring the necessity for pedagogical approaches that specifically address the cultivation of this skill.

This study proposes and empirically assesses a conceptual framework for harnessing GAI to boost critical thinking skills. This study addresses the research question, "Can GAI be integrated into higher education setting to promote critical thinking ability?". The framework offers structured guidance for students to critically evaluate and build on AI-generated information. Stages involve forming focused questions, gathering diverse ChatGPT perspectives, assessing responses, synthesizing insights, and reflective learning. This seeks to provide a framework for interactions that encourage critical analysis of AI output rather than passive consumption.

Twenty undergraduate students took part in an empirical study that was conducted to evaluate the framework's effect on critical thinking. Lee's thinking levels model [8], which has three levels of thinking: recall, rationalization, and reflectivity, was utilized to assess student responses. Findings showed when students used the framework to direct ChatGPT use, their critical thinking significantly improved, with average thinking levels rising from recall to rationalization. A survey also revealed student opinions on how ChatGPT helped idea generation and critical analysis. This study gives preliminary evidence that the framework can enhance critical thinking by leveraging AI capabilities.

The following sections comprise the paper: the introduction discusses the study's background, purpose, goals, research question, and an overview. Relevant prior works are summarized in the literature review. The methodology section provides details on the suggested framework and empirical analysis design techniques, as well as the survey. The discussion and conclusion highlight the examination of survey data and outcomes. There is also a discussion of limitations and challenges. Lastly, the contributions and possible future works are summed up in the conclusion.

2. Literature Review

ChatGPT has emerged as a powerful conversational AI agent that can generate human-like text on a wide variety of topics [9]. However, there are concerns that overreliance on it could lead to issues like a lack of critical thinking, plagiarism, and the spreading of misinformation [10]. This highlights the need for developing frameworks and guidelines to promote critical thinking while using it responsibly. This literature review summarizes key studies on leveraging ChatGPT and similar AI agents to enhance necessary thinking skills.

Several studies have explored the integration of GAI-powered tools in an educational setting. Javaid et al. [11] proposed using ChatGPT as a teaching assistant to provide students with feedback on assignments and prompt them to think more deeply about course concepts. They found that it could ask thought-provoking questions and point out flaws in students' reasoning, which helped improve critical analysis skills. Dai et al. [12] conceptualized ChatGPT as a student-driven invention with enormous potential to empower students and enhance their educational experiences and resources.

Other studies have focused on mitigating the risks of over-dependence on ChatGPT. Kasneci et al. [13] emphasized that educational systems need a clear strategy and pedagogical approach focused on critical thinking and fact-checking to integrate large language models. Moreover, there is a clear need for teachers to be trained to use the tool properly to use the full potential of ChatGPT in education [14]. Unethical or dishonest practices are raised by the application of AI in the classroom [15]. It may lead to a decline in critical thinking skills among students, particularly in essay writing [16]. Rusandi et al. talk about the role of ChatGPT in education and research and the need to maintain academic integrity [17]. Jeyaraman et al. emphasize the importance of academic integrity and critical thinking in students' work [18]. Birenbaum explored that Chatbots are great for answering grammar questions or helping with writing, but they may limit creativity [19].

Lo [20] proposes a framework for leveraging GAI in teaching and learning. They discuss the potential benefits and challenges of using it in education and provide recommendations for addressing the issues associated with its use. Murad et al. [21] provide a framework for incorporating GAI into educational contexts. In their study, Fütterer et al. discuss the potential benefits and challenges of using ChatGPT in education and provide a framework for incorporating it into teaching [22]. In a similar study, Kooli offers suggestions for resolving the issues related to the usage of GAI-powered chatbots in educational settings as well as a framework for doing so [23].

From the existing literature, it is evident that GAI shows promise of integration into education. The literature also indicates the risks of overdependence on AI. Developing robust instructional frameworks represents a promising path

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to promote judicious and ethical usage of GAI as a tool for critical thinking. More empirical research is needed to guide the design and evaluation of such frameworks to fully realize the potential of AI in education.

Therefore, by incorporating GAI into higher education, this study proposes a conceptual framework to promote students' critical thinking. The well-designed framework is supported by empirical and theoretical studies. The well-designed framework is supported by empirical and theoretical studies.

3. Methodology

The overall methodological approach of this study is presented in Figure 1, comprised of literature review, proposing the conceptual model, empirical study, and evaluation of the proposed framework.
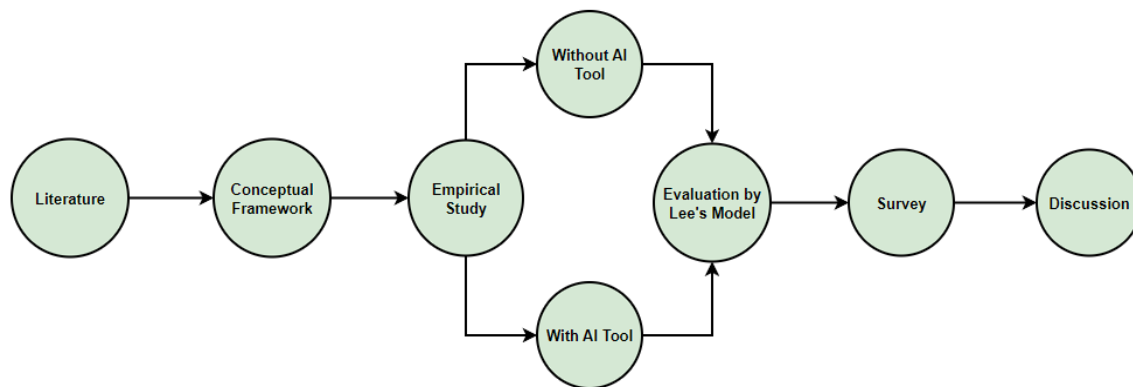

Figure 1: Methodological Approach

3.1. AI-CRITIQUE: The Proposed Framework

In this study, a conceptual framework, "AI-CRITIQUE" (AI-based Critical Reflection and Insightful Thought Unleashed for Education) is proposed. The primary objective of this framework is to leverage the unique characteristics of modern generative artificial intelligence (GAI) systems in order to enhance critical thinking and cognitive abilities among students. In order to effectively accomplish the primary objective of the framework, it is imperative for a student to adhere to the sequential and incremental stages that form its foundation. The proposed framework is shown in Figure 2.
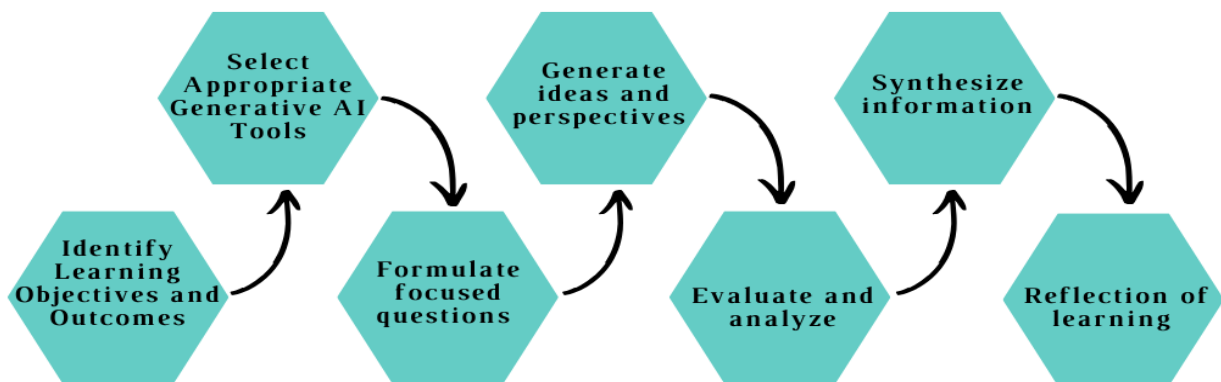

Figure 2: The proposed framework (AI-CRITIQUE)

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- Identify Learning Objectives and Outcomes

Educators explicitly define the desired educational objectives that necessitate advanced cognitive abilities, including critical analysis, creative ideation, and evaluative reasoning. Clearly defined learning objectives provide a roadmap for the instructional process [24]. They help connect learning activities and assessments to desired goals. Objectives should be specific, measurable, achievable, relevant, and time-bound. Establishing precise objectives creates a clear sense of purpose and guidance for the generating actions.

- Select Appropriate Generative AI Tools

Students have the freedom to select from a variety of generative tools for the purpose of enhancing their learning experience. In this study, ChatGPT was chosen as the primary tool due to its widespread recognition, popularity, and accessibility to the general public.

- Formulate focused questions

The students proceed to generate specific and open-ended inquiries in order to guide the chatbot. The utilization of meticulously constructed prompts increases the probability of obtaining coherent and relevant responses from AI. The purpose of questions is to generate novel perspectives rather than simply reiterate established information. In order to promote higher-order cognitive skills, it is recommended that questions be designed to elicit critical thinking rather than mere factual memory.

- Generate ideas and perspectives

The AI-powered tools produce output that is relevant to the given prompts, although it may be flawed at times. Critical thinking activities encourage students to have a wide variety of ideas. Brainstorming sessions, free writing, and open-ended questions can stimulate creative ideation. Inquiry-based learning fosters curiosity and exploration of multiple viewpoints [25]. Students learn to ask thoughtful questions, research various sources, and develop their own hypotheses. Thus, they are encouraged to engage in the process of gathering an extensive range of ideas and critically analyzing the rationale that lies behind them.

Evaluate and analyze

It is essential that the learner engage in a critical reading of the AI-generated responses. They ought to think about the viewpoints that are being represented and the underlying assumptions that are being made. A student should also consider and reflect on the reasoning, evidence, or data support presented by the response of GAI tools for each perspective. This pushes the student to dig deeper into the validity of different arguments.

- Synthesize information

The students should be able to summarize the main points and combine insights from the various AI-generated responses. This necessitates separating reliable facts from unreliable arguments. Through the integration of personal knowledge and the insights derived from AI-produced answers, individuals can establish innovative connections between the generated ideas and external sources, thereby formulating new perspectives on many subjects.

- Reflection of learning

Reflective learning focuses on the development of students' cognitive processes [26]. It is imperative to offer students the chance to engage in reflective practices that facilitate an examination of the progression of their cognitive processes. The primary objective of the framework is to enhance metacognitive abilities and foster motivation for continuous intellectual development. Further iterations can improve critical thinking abilities over time.

This framework offers a structured approach to efficiently include GAI in order to facilitate higher-order thinking and contemplation. The next part presents an empirical investigation of the framework to assess its efficacy.

3.2. Empirical Study

To gain proper evidence of the effectiveness of the proposed framework, 20 undergraduate students were experimented on. Among them, 12 were male and 8 were female. The students were first given an article [27] to read in this experiment. Because the topic selected is a broad issue, this article was chosen, and the students were asked questions about it for evaluation. Since every participant in the experiment had a background in computer science, effort was made to ensure that the question was not biased. The students were asked to answer an opinion-based question on the

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article's subject. An opinion-based question encourages the students to brainstorm ideas rather than just recall what they have learned [28]. Next, the students were asked to answer the question without using any AI tools. As the whole experiment was conducted online, in this process, they could use the help of the internet to back their answer, generate ideas, and learn more about the topic to answer the question. Then, the students were asked to answer the same question again, this time using AI tools. They prompted and learned more about the topic with the help of AI to answer the question. In this process, they followed the proposed framework for answering the question while using ChatGPT. Figure 3 demonstrates a sample survey form provided to the students to record their responses.

Figure 3: Opinion-based question form

3.2.1. Data Consent

The experiment conducted was an open experiment. All participants participated in the investigation of their own volition. No personal information of any participants was recorded or disclosed.

3.2.2. Evaluation by Lee's Thinking Model

The well-known Lee's thinking level model, which consists of three thinking levels, was utilized to determine the participant's answers in both the ChatGPT-assisted and non-ChatGPT-assisted scenarios to achieve a higher thinking level. Table 1 demonstrates Lee's model of thinking along with a brief description of each level that can be considered as an evaluation coding scheme.

The in-detail results and findings of the evaluation according to Lee's model of thinking are discussed and presented in the "Evaluation Results" section.

Table 1. Lee's Model of Thinking

Levels of Thinking	Degree of Levels	Lee's Model	Description of Lee's Model
Level 1	Lowest	Recall	The same information being repeated

| Level 2 | Intermediate | Rationalization | Examine the content (the information) rationally. |
| Level 3 | Highest | Reflectivity | Think critically beyond the bounds of the available information. |

3.3. Survey

After the collection and assessment of responses from students in both experimental conditions, wherein they answered a question without the assistance of GAI tools and with the aid of such tools, the following questions were asked. This survey of the participants aims to gain insight into their perspectives on the impact of utilizing AI in answering questions comparing their experiences with and without AI assistance. Additionally, it seeks to determine whether students believe that using AI tools to get information on a specific topic enhances their critical thinking abilities and improves the quality of their responses. Participants were requested to provide their responses to the question while utilizing our suggested framework when used with AI technologies. Additionally, they were asked to express their perspective regarding whether the framework facilitated their ability to engage in more profound levels of thinking.

The measurement tool used for the survey questions was the Likert scale [29]. The survey uses the scale as it provides respondents with multiple options for how much they agree or disagree with a certain question. The study's participants are offered multiple choices, which range from "Strongly Disagree" (1) to "Strongly Agree" (5). A sample survey response form is depicted in Figure 4 below.

Figure 4: Survey questionnaire with a sample response

4. Results and Discussion

This section presents a comprehensive analysis of the evaluation results and survey data, along with a discussion of the significance of the findings. The study's limitations and challenges, as well as the suggested framework, are also mentioned.

4.1. Evaluation Results

The collected responses through the survey from the participants were assessed based on three levels of thinking - recall, rationalization, and reflectivity, according to Lee's thinking level model. Their responses were first evaluated in the experimental context, where participants provided answers both with and without the assistance of AI. In order to determine whether their level of thinking increased in response to prompting and after learning more from ChatGPT using the proposed framework, the evaluation results before and after using AI will be compared. The sample evaluation of a student's responses, both with and without ChatGPT, is depicted in Figure 5.

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Besides, the evaluation results for every student in both experimental setups are displayed in Figure 6. When they utilized AI as a supporting tool to help them answer the topic, the majority of students displayed an increase in thinking ability. Whether they are using ChatGPT or not, some students do not demonstrate any increase in their thinking ability. Whether or not they use AI technologies to answer the question, all five students exhibit the same level of rationalization. Seven students, out of those that show an improvement in thinking level while using AI, go from the lowest thinking level recall to rationalization. After responding with AI assistance, two of them go from the second level of rationalization to the third and highest degree of thinking reflectivity. This demonstrates how AI tools can raise cognitive levels. Utilizing ChatGPT to generate ideas for answering the question, the six students remarkably demonstrate an increase in thinking level from the lowest level when they were not utilizing AI to the highest level when they were. The findings provide evidence that thoughtfully incorporating AI into the learning process can push students to think more critically and reach higher levels of reflection, and thus, they can be encouraged to think beyond boundaries.
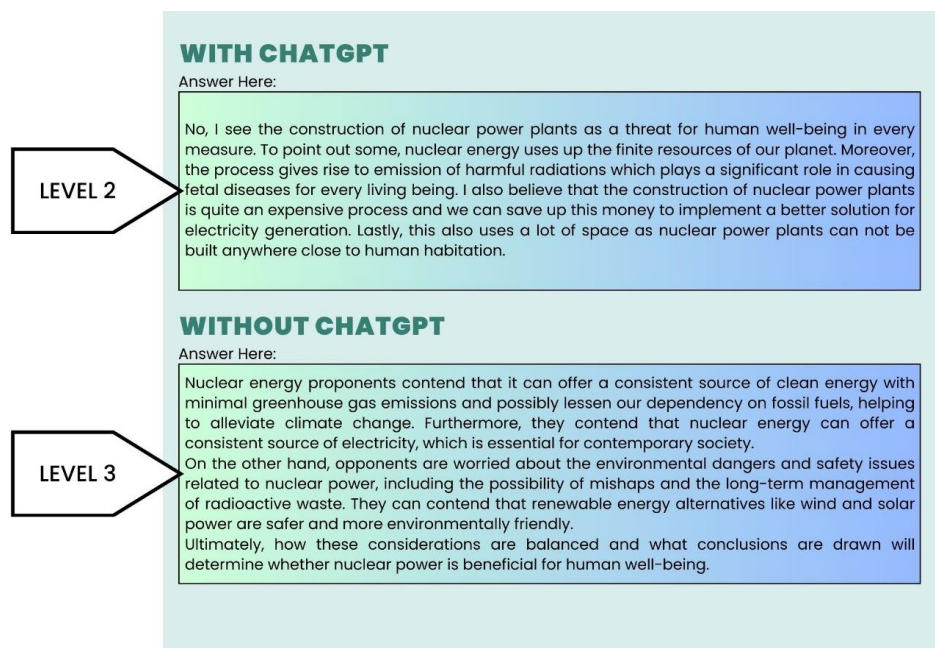

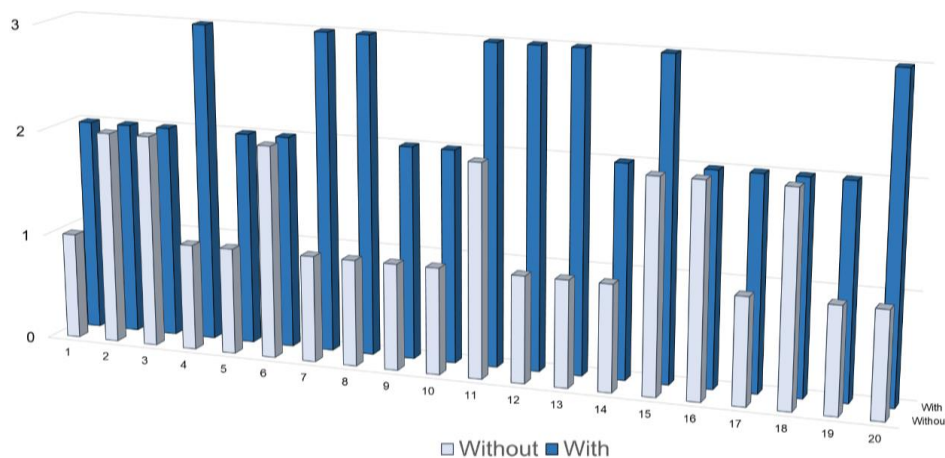**Figure 5: Sample of one response evaluated using Lee's Model of Thinking**

Figure 6: Thinking level of each student with and without using ChatGPT

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The average thinking level scores for each set are displayed in Figure 7 for both cases such as with and without assistance from AI while responding to a question. When students responded without the use of such tools, their average thinking level was 1.35. This indicates that in this particular case, the average thinking level was closer to recall, which is the lowest thinking level in Lee's thinking model. When students employed AI to help them with their answers, their average score increased. With AI support, the average score increased significantly to 2.4, which is about midway between the highest level of "reflectivity" and "rationalization." The findings show that when students used AI support to find answers to questions, their critical thinking abilities improved.
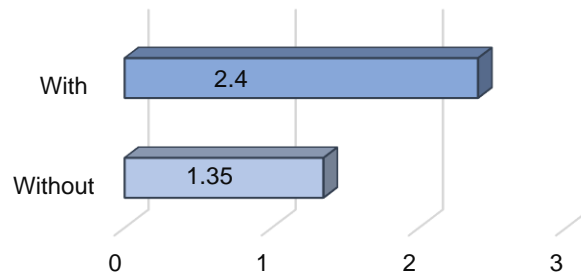

Figure 7: Average thinking level of each student with and without using ChatGPT

As students used the proposed framework to interact with the GAI directly, the study methodology gives the framework validity. The improvements in critical thinking provided empirical evidence of the framework's effectiveness in directing the integration of GAI to enhance cognitive abilities. Students were able to use the GAI technology for more in-depth investigation, evaluation, and synthesis since the framework provided guidance related to the GAI experience. So, the students' achievements offer empirical support for the framework's usefulness in adapting GAI tools in education to promote critical thinking ability.

4.2. Survey Analysis

The answers to the survey questionnaire of 20 students who participated in the experiment are presented in Figure 8. The scale of answering questions ranges from 1 to 5 (where 1= Strongly Disagree, 2 = Disagree, 3 = Neither Agree or Disagree, 4 = Agree, 5 = Strongly Agree).
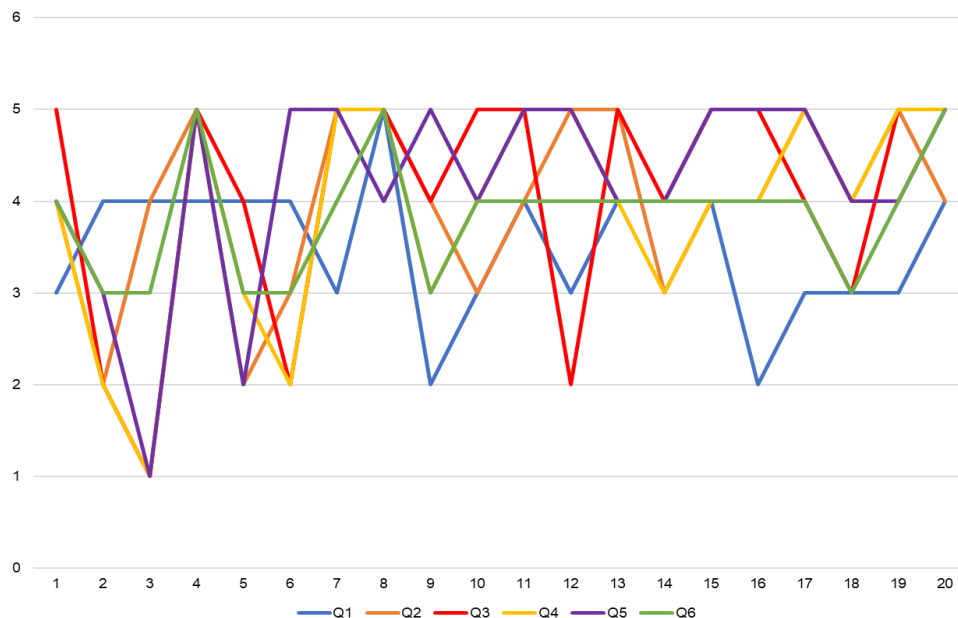

Figure 8: Answer ratings for each survey question (Q1 - Q6)

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The average score for each of the six survey questions that students answered is displayed in Figure 9.
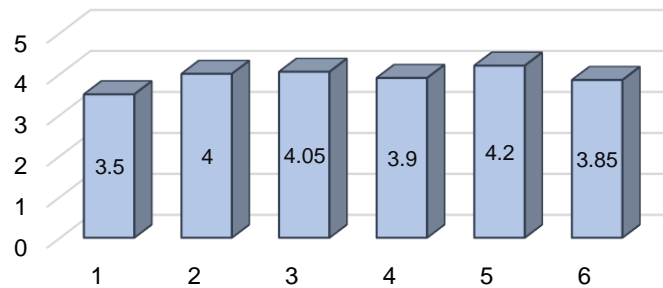

Figure 9: Average ratings for each survey question

The data indicates students found independent creativity and critical thinking moderately challenging, rating it 3.5 out of 5 for difficulty. However, AI tools substantially boosted their capacity for idea generation and critical analysis, with a rating of 4.0. This implies that AI-enabled students tap into perspectives and insights they would not have developed independently. Notably, students reported AI helped them generate more unique, creative, and quality ideas than their solo efforts. The 4.05 uniqueness rating suggests AI opened up unconventional avenues of thinking. Meanwhile, the 3.9 quality rating indicates AI assisted students in developing more thoughtful, meaningful ideas. Additionally, the critical thinking enhancement rating of 4.2 indicates AI prompted more in-depth mental engagement with the material. This shows its value in motivating students to dig deeper rather than taking ideas at face value. The framework's rating of 3.85 is promising regarding its potential to optimize AI's benefits.

These promising results validate GAI's value in amplifying imagination, creativity, and critical thinking. The framework shows initial potential for guiding meaningful use to promote critical thinking using ChatGPT.

5. Limitations & Challenges

Though the framework proposed is well thought out and backed by empirical study, it still has some limitations. While this preliminary study demonstrates the promise of the proposed framework, more empirical research examining long-term impacts on higher-order cognitive abilities is essential. The sample size used in the empirical study was relatively small (20 students), making it difficult to generalize the findings. More large-scale studies across diverse educational settings are needed to further validate the framework's efficacy. The framework was tested in a controlled experimental setting, which may not fully simulate real-world learning environments that are often complex and unpredictable. Evaluating the framework's effectiveness when integrated into actual curricula is an essential next step.

Moreover, issues around the reliability and accuracy of AI systems pose challenges. Despite its unique abilities, ChatGPT occasionally produces inaccurate, biased, or incomplete information [30]. Additional drawbacks include the potential for an over-reliance on ChatGPT to hinder original thought and just replicate concepts created by AI. Promoting more human-AI collaboration in education settings can solve this issue.

6. Conclusion

This study proposes and assesses a conceptual framework for incorporating GAI systems into higher education to foster critical thinking abilities. Our empirical study provides strong support for the framework. The empirical study offers preliminary evidence that supports the effectiveness of this framework in enhancing critical thinking skills. When students used the framework with ChatGPT, their cognitive levels went from poorer recall to more significant rationalization, according to Lee's thinking levels model analysis. According to additional survey data, students believed that using AI in comparison with working alone enhanced their ideation, increased their creativity, and allowed for more in-depth critical analysis.

There are a number of possible directions for further research in order to expand on the findings from this initial investigation. Further extensive and extended applications of the framework in other educational contexts may provide more insightful results. Evaluating its generalizability by doing research in various age groups, academic levels, and topic areas can be a good future study. Moreover, illustrating its effects may be comparisons between traditional

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instruction on its own and instruction that incorporates the framework. A possible future work can be to iterate on the framework itself. It could be improved by exploring the best prompting techniques, assessing various GAI models, and combining other instructional methodologies.

Overall, the suggested framework shows how AI has the potential to be an effective tool for enhancing critical thinking, creativity, and cognitive development when used carefully. To maximize benefits and minimize risks, responsible design, moral usage guidelines, and human direction are essential. This work provides the first GAI-directed framework for the growth of higher-order thinking levels in educational settings.

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