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Can ChatGPT Serve as a Cognitive Stimulus? A Proposed Model for Assessing the Impact on Graduate Students' Perceptions of Cognitive and Developmental Skills

Hamdan Alabsi[1]* · **Majed Almotairi[2]†** · **Mohammed Alyami[3]†** · **Yahya Alqahtani[4]†** · **Rand Obeidat[1]†** · **Faris Almansour[5]†**

Abstract This research explores whether ChatGPT – as one significant contributor to the integration of Artificial Intelligence (AI) into daily life- can act as a cognitive stimulus to improve graduate students' learning experiences in the classroom. This study proposes a theoretical model to assess graduate students' perceptions of ChatGPT to explore whether its use positively or negatively affects stimulating their cognitive skills. Cognitive Load Theory was used in this research to examine how ChatGPT can be a mediator factor impacting cognitive load reduction, critical thinking, creativity, and problem-solving abilities. It is worth noting that this model has not been tested yet; future research will focus on data collection and hypothesis testing.

Keywords ChatGPT · Artificial Intelligence (AI) · Cognitive Skills · Cognitive Load · E-learning.

1 Introduction

Artificial intelligence (AI) has profoundly impacted various aspects of individuals' lives, influencing healthcare, business, and education perspectives. With the rapid proliferation of AI applications, discussions surrounding its controversies have spanned from subject matter experts in academia and industry professionals to the public worldwide, questioning its intelligence, capabilities, and scalability. Many individuals hold conservative opinions regarding AI, perceiving it as a technology with limited capabilities and intended functionalities. In contrast, others see it as proficient in efficiently executing repetitive tasks, mimicking human procedural and systemic approaches. Yet, some perceive AI's capabilities and scalability as limitless, surpassing expectations. Despite the divergent trends and discrepancies in viewpoints among individuals, it's clear that the world is entering what could be termed an "AI-oriented world," marking a new era of human advancement. One significant contributor to the integration of AI into daily life is ChatGPT, the renowned chatbot developed by OpenAI. Remarkably, within two months of its launch on November 30, 2022, ChatGPT boasted an estimated 100 million monthly active users [15] [22].

Indeed, academic institutions must recognize the impact of this evolving AI tool on adopting E-learning, particularly in light of the significant rise in ChatGPT usage among students globally. This paper proposes a model to investigate graduate students' perceptions, particularly those who use ChatGPT to complete their university assignments. Furthermore, the research aims to determine whether ChatGPT can act as a cognitive stimulus, reduce cognitive overload, and consequently enhance students' problem-solving, critical thinking, and creativity, ultimately contributing to an overall improvement in learning outcomes. This paper is structured as follows: the Research Motivation, Research Gap and Questions, followed by the Literature Review, Theory & Hypotheses, Methodology, and Conclusion sections.

1.1 Research Motivation

The frequency of ChatGPT utilization among college students is steadily rising, with a considerable number already integrating its capabilities into their academic endeavors [7].

[1]Management Information Systems Dept, Bowie State University, Bowie, 20715, MD, USA.

[2]Information Systems Dept, Indiana Institute of Technology, Fort Wayne, 46803, IN, USA.

[3]Computer Information Systems Dept, Colorado Mesa University, Grand Junction, 81501, CO, USA.

[4]Computer Science Dept, Jazan University, Jazan, KSA.

[5]Information Technology Dept, Saudi Electronic University, Riyadh, KSA.

*Corresponding author(s). E-mail(s): halabsi@bowiestate.edu
Contributing authors: MMAlmotairi@indianatech.edu, malyami@coloradomesa.edu, yalqahtani@jazanu.edu.sa, robeidat@bowiestate.edu, f.almansour@seu.edu.sa.
†These authors contributed equally to this work.

A study on 1,000 current undergraduate and graduate students revealed that more than half (51%) acknowledged ChatGPT's assistance completing coursework effectively [21]. Another study surveying 588 college students revealed that 37% currently utilize ChatGPT [17]. Furthermore, ChatGPT has been shown to significantly enhance productivity, with an MIT study indicating a remarkable 40% increase in productivity and a 20% improvement in quality across various tasks, including crafting cover letters, drafting delicate emails, and conducting meticulous cost-benefit analyses, benefiting professionals such as data analysts and human resource specialists [12][26]. Recent research indicates that the increased usage and integration of ChatGPT among college students has shown improvements in students' performance and work quality. This research aims to propose a model that explores whether ChatGPT functions as a catalyst for reducing cognitive load and enhancing cognitive skills such as problem-solving, critical thinking, and creativity, particularly among university students. Numerous E-learning tools are available; however, generative AI tools like ChatGPT have emerged as the most common and influential among students. Several E-learning platforms have already integrated ChatGPT in various forms, such as virtual tutoring, to assist students in overcoming challenges in different areas of their studies, and more integrations are expected in classroom settings.

1.2 Research Gap and Questions

While significant research studies have addressed the ethical concerns surrounding the integration of AI in academia and its impact on students' experiences and outcomes, there remains a scarcity of research concerning AI's influence on students' cognition in academic settings, particularly at the graduate level [2][16]. Although researchers have investigated the usage of ChatGPT and its effect on cognitive skills, these studies primarily focus on undergraduate students who may be affected by such technology, potentially impacting their acquisition of knowledge and skills due to a lack of sufficient foundational knowledge and functional understanding at the undergraduate level [8] [19][25].

However, our research focuses more on graduate students who have already completed all the foundational courses, commonly known in most universities worldwide as liberal arts, core courses, and elective courses. In addition, some of these graduate students may possess professional experience or currently hold a professional position, meaning they have already acquired a solid knowledge base.

This research aims to address and explore this following question:

Graduate-level university students experience a reduced cognitive load that enhances cognitive abilities when they use AI-supported tools such as ChatGPT to complete their schoolwork.

2 Literature Reviews

Since OpenAI launched ChatGPT, many researchers have started to investigate its functionality, ethics, and impact on education and cognitive skills. Bai et al. have mentioned that educators can incorporate learning activities using ChatGPT to promote critical thinking and problem-solving and to support personalized learning. However, the researchers strongly argue about the potential risks of using ChatGPT. Bai et al. fear that individuals may become over-reliant on using AI tools, which could lead to a reduced capacity for critical thinking or a decline in memory retention [4]. Some researchers have addressed the ethical implications of ChatGPT. For example, Farhi et al. analyzed students' views, concerns, and perceived ethics regarding ChatGPT usage. The researchers concluded that while using chatbots is helpful, it raises concerns about educational integrity. They mentioned that implementing practical guidelines can assist in making informed decisions and shaping policies within educational institutions [10] . Similarly, another study examined university students' perceptions of using ChatGPT in education. The study revealed that students perceive ChatGPT as a tool that saves time, provides information in various areas, offers personalized tutoring and feedback, and assists in brainstorming and writing. However, the same study also indicated that students expressed some concerns, such as the inability to assess the quality and reliability of sources and the failure to cite sources accurately [20]. On one hand, Holmes et al. argued in their book that Artificial Intelligence in Education can be integrated into curricula and pedagogy, utilizing AI to enhance student outcomes [14]. On the other hand, while Saritha et al. suggested careful consideration regarding the complexities of integrating AI technologies like ChatGPT into educational environments, the researchers also observed challenges in stimulating critical thinking and critical thinking skills. They noted a decline in the stimulation of critical thinking and enhancement of problem-solving skills post-adoption [23]. Similarly, Fulbright and Morrison investigated human cognitive augmentation through the use of ChatGPT by conducting experiments. Their results suggested that using ChatGPT does not always lead to cognitive augmentation. They observed instances where ChatGPT provided misleading outputs to users, resulting in negative cognitive augmentation [11]. However, Mollick suggested that AI can be crucial in facilitating learning environments, especially in knowledge transfer [19]. Some students do not perceive cognitive enhancement because they have not yet been adequately trained to interact effectively with ChatGPT to extract useful information. The lack of guidance on how to use ChatGPT in educational settings could be a contributing factor. Therefore, it is essential to consider the need for comprehensive training programs that teach students how to utilize ChatGPT and discern and evaluate the quality of

the information provided. By addressing these educational needs, we can ensure a more significant impact of ChatGPT on cognitive enhancement among students.

3 Theory & Hypotheses

3.1 Linkage to Existing Theories

This research also draws on the Cognitive Load Theory formulated by John Sweller (1988), which suggests that working memory has a limited capacity and emphasizes the importance of minimizing extraneous cognitive load to maximize learning. ChatGPT could help reduce cognitive load by providing quick and easy access to vast information, facilitating the expansion of students' knowledge base. As a result, students can prioritize, conserve, and allocate their cognitive resources to tackle more complex problems rather than those requiring less cognitive engagement[3][6][24]. Cognitive load may act as a mediating factor that enhances cognitive abilities while using ChatGPT. This concept can be connected to the NASA Task Load Index (TLX), a tool for assessing subjective workload. The TLX allows users to evaluate the cognitive load experienced by operators interacting with various human-machine interface systems [1].

3.2 Testing Hypotheses

This research will evaluate the following hypotheses to determine whether there is a correlational relationship or not:

Hypothesis (H1): Utilizing AI tools like ChatGPT to complete university assignments positively correlates with enhancing problem-solving skills through reducing cognitive load.

Hypothesis (H2): Utilizing AI tools like ChatGPT to complete university assignments positively correlates with enhancing Creativity through reducing cognitive load.

Hypothesis (H3): Utilizing AI tools like ChatGPT to complete university assignments positively correlates with enhancing critical thinking through reducing cognitive load.

3.3 Variables and operationalization

Fig 1 depicts the proposed model, illustrating how the use of ChatGPT (X) may influence cognitive skills by reducing the Cognitive Load (M), which in turn enhances Problem-Solving (Y1), Creativity (Y2), and Critical Thinking (X3).

4 Methodology

For this research, the unit of analysis will likely be the "individual," specifically graduate students at universities. We will investigate whether students perceive cognitive stimuli when utilizing AI-supported tools like ChatGPT to complete their schoolwork. A survey will serve as the primary data collection method. The survey questionnaire will be adapted from existing studies to meet the specific needs of this research. We will adopt a similar methodology to these studies but customize it to suit our needs for testing my hypotheses [13][9][27].

4.1 Framework Process for Mediation Model

Fig 2 illustrates the process flow of the analysis. The study begins by collecting student data on ChatGPT usage, cognitive load, problem-solving, creativity, and critical thinking. After preparing the data, a mediation model is set up to explore the relationships between these variables, with ChatGPT usage as the independent variable, cognitive load as the mediator, and cognitive outcomes as the dependent variables. Regression analyses are conducted to assess the effects of ChatGPT usage on cognitive load (Path a) and cognitive outcomes through cognitive load (Path b). The results are extracted and interpreted, focusing on direct, indirect, and total effects (Path c). Finally, the findings are visualized and summarized to understand how ChatGPT usage impacts cognitive skills comprehensively [18][5].

5 Conclusion

The main goal of this study is to develop a model to explore the potential relationship between ChatGPT usage and cognitive stimulation among graduate students working on their university assignments. The results are expected to support the proposed hypotheses by implementing and testing this model. A key limitation of this study is the absence of real-world data to test the proposed hypotheses objectively. In the future, we will collect data and test this proposed model. Moreover, the students may be influenced by biases such as answer accuracy, non-response bias, and social desirability bias, which could impact the validity of the results.

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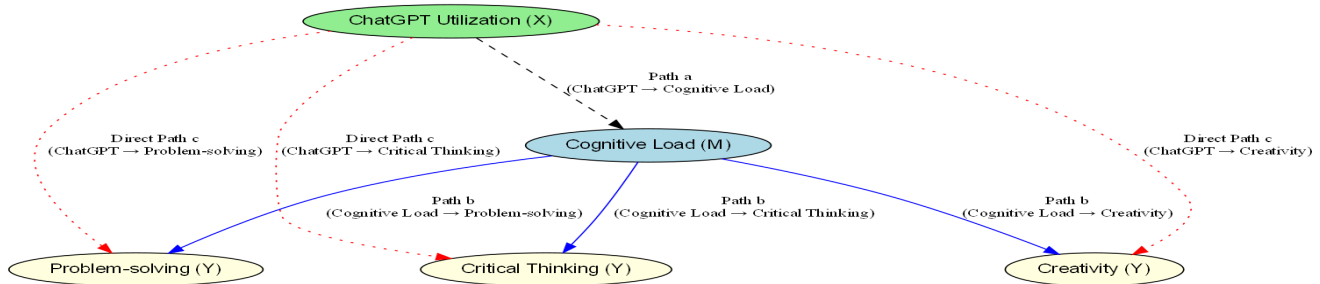
Fig. 1 The relationship among the variables in this proposed model.
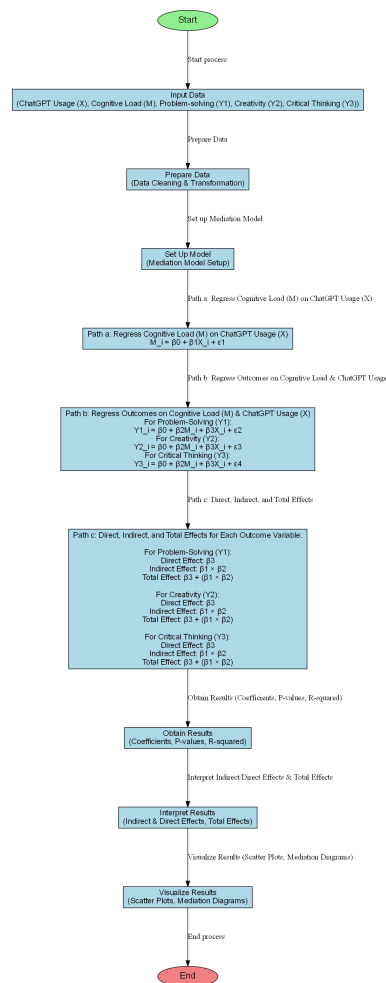

Fig. 2 Framework for Mediation Analysis of ChatGPT Usage on Cognitive Abilities

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