Using Generative AI to Solve Technical Problems: Student Results and Perceptions

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ChatGPT is a large language Artificial Intelligence (AI) model developed by OpenAI released for public use in November 2022 (Trust et al., 2023). ChatGPT was pre-trained on large volumes of text and predicts the next word given the previous words in a sequence of text (Ray, 2023). Higher education faculty have mixed feelings about ChatGPT; some are concerned about negative implications for academic integrity and potential disruption of the teaching and learning process, while others are excited about the possibility of incorporating a powerful new tool into teaching and learning (Trust, et al., 2023; Yu, 2023).

Theoretical Framework

To explore students' attitudes toward ChatGPT as a teaching and learning tool, we used the Two-Stage Model of Cognition Change (Bhattacherjee & Premkumar, 2004) and Self-efficacy Theory (Bandura, 1997). The Bhattacherjee & Premkumar model examines technology users' pre- and during usage beliefs and attitudes to determine their satisfaction or disconfirmation and final decision regarding adoption of a technology. In the context of this study, students' expectations regarding ChatGPT should influence their perceived confidence in the technology. Subsequent use of ChatGPT should help them determine whether the technology performs better or worse than initially expected. We were interested to determine if this disconfirmation stage helped students form new perceived attitudes toward ChatGPT (Lankton et al., 2014). Self-efficacy theory (Bandura) also informed this study, as students' confidence should increase resulting from mastery experiences using two methods to analyze hydraulic systems.

Objectives

The objectives of this project were to compare the accuracy of technical problem-solving results generated by ChatGPT and traditional hand calculations, determine students' confidence in the accuracy of ChatGPT and hand calculation results, and determine students' perceived need for development of quantitative problem-solving skills given the availability of ChatGPT.

Methods

The free version of ChatGPT (3.5) was incorporated into a single class meeting of a first-year agricultural systems technology course to analyze the extension and retraction forces (lbs) and total cycle time (seconds) for a 4-in (bore) x 16-in (stroke) x 2-in (rod diameter) hydraulic cylinder operating on a system with a maximum pressure of 2250 psi and a pump flow of 14.5 GPM. Students ($N = 31$) were instructed to write and enter a single ChatGPT query to compute all solutions. Students then copied and pasted their queries into an online assignment form. Students extracted ChatGPT's solutions and entered them into the online form and then rated their level of confidence (1 = extremely unconfident, 5 = extremely confident) in the accuracy of the ChatGPT answers. Next, the instructor guided the class through the process of quantitatively analyzing the hydraulic system via an interactive lecture where the applicable concepts and formulas were introduced where students applied them to analyzing the hydraulic system. Student-generated answers were also entered into the online form and students rated their level of confidence in their accuracy. Next, the students compared the ChatGPT and class generated answers and re-rated their level of confidence in the accuracy of the ChatGPT solution. Finally, students responded in text to the (ungraded) prompt, "With the advent of ChatGPT and other

generative AI programs, is it still important to develop analytical and computational skills? Briefly explain why or why not." Students then submitted the online form for grading.

Data for the first two objectives were analyzed using descriptive statistics. For objective three, a thematic content analysis (Smith, 1992) was performed on the open response prompts. The PI served as an independent reviewer and used inductive coding on the data. Data were pre-coded by highlighting standout phrases regarding student perceptions and attitudes toward their ChatGPT experience. Phrases were reviewed and categorized relating to the general ideas suggested by the data. Next, data were clustered by thematic category and commonality (King Brooks, 2017). After defining the categories, three theoretical constructs were developed, which guided the report summary.

Results

The majority of students (66.7%) reported never using ChatGPT before this exercise. Most students' (63.3%) ChatGPT results for the cylinder's extension force were correct, but only 10.0% and 3.3% generated correct responses for retraction force and cycle time, respectively. Analysis of the student-generated queries indicated 60.7% contained all the specifications and instructions necessary to generate complete and accurate responses. For the student-generated responses, 96.7%, 96.7%, and 93.3% were correct for extension force, retraction force, and cycle time, respectively. Initial confidence in the ChatGPT results (M = 2.57, SD = 1.10) decreased (M = 1.97, SD = 1.03) after comparison with the student-generated responses. This decrease was statistically significant [$t(29) = 2.23$, p - .03] and represented a small (Cohen, 1988) effect. Conversely, students were confident (M = 4.53, SD = 0.97) hand-calculated results were correct.

Three themes were developed from the open-ended responses: (a) distrust of AI, (b) value placed on human factor, and (c) shared concern for human and technological error. Upon analysis, all respondents suggested they believe it is important to develop analytical and computational skills despite the opportunity to utilize ChatGPT and other AI tools. Further, the qualitative evidence suggested a strong observable pattern in the distrust of AI's capability. Students consistently referenced the lack of human behavior and influence in AI, which led them to question ChatGPT's reliability. Rather, students preferred a human element when attempting to solve complex problems. Students indicated a reluctance to use AI, as they distrusted their personal knowledge of the technology's functionality as much as they distrusted the technology itself.

Conclusions/Implications/Recommendations

According to the theoretical model, students' initial attitudes changed after using ChatGPT (Bhattacherjee & Premkumar, 2004). Students lacked initial confidence in ChatGPT, perhaps because of inexperience (Bandura, 1997). Students' confidence was lower after using the technology, suggesting potential dissatisfaction with the technology's performance (Lankton et al., 2014); despite most queries being written correctly, ChatGPT consistently provided wrong answers. Open-ended responses also confirmed students' distrust in ChatGPT. Alternately, students were more confident in their hand calculated results. As AI technologies become more prevalent, instructors should consider the implications for teaching and learning. If instructors choose to use AI in the classroom, instruction should be included on how to conduct appropriate queries. AI can be a powerful teaching tool; however, further research into how ChatGPT can effectively be used in the classroom should be conducted.

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