AI TOOLS FOR ACCELERATED LEARNING

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ABSTRACT

Large language models are changing the pedagogical and learning landscapes. This study examined the effects of students who did and did not use ChatGPT in an academic exercise at Patrick Henry College. Students who used ChatGPT in the exercise achieved significant *insight advantages* over students who did not. The insight advantages, however, did not result directly from using ChatGPT. More research is needed, particularly in prompt engineering, to advance the use of large language models.

Keywords: *AI, ChatGPT, insight advantage, large language models, prompt engineering*

Large language models are changing the pedagogical and learning landscapes. This study examined the effects of students who did and did not use ChatGPT in an academic exercise at Patrick Henry College. Students who used ChatGPT in the exercise achieved seven times the number of *insight advantages* than students who did not. The insight advantages, however, did not result directly from using ChatGPT. More research is needed, particularly in *prompt engineering*, to advance the use of large language models. This paper begins with an analysis of Patrick Henry College and its Strategic Intelligence program and the mixed reception of AI in the public consciousness in late 2022. It then describes the experimental design and quantitative results of this study. Next, the author presents a process and a theoretical framework to explain the results. Lastly, the author identifies the limitations of this research, makes recommendations, and shares final observations.

PATRICK HENRY COLLEGE'S STRATEGIC INTELLIGENCE PROGRAM

Patrick Henry College is a private Christian institution established in 2000 in Purcellville, Virginia. The Southern Association of Colleges and Schools and the Transnational Association of Christian Colleges accredit the College. The College's distinctive high academic rigor, fidelity to the spirit of the American founding, and unwavering biblical worldview educate the brightest Christian students to compete and lead at the uppermost levels of society. The campus population of undergraduate students is approximately four hundred students. The College's forensics teams compete at the highest levels in moot court, debate, and mock trials (Patrick Henry College, 2024). The Strategic Intelligence in National Security program is housed in the Department of Government. The International Association For Intelligence Education certifies that students in the program are provided with a rigorous and systematic study of the intelligence discipline. They are equipped to influence the intelligence and national security endeavors of the United States. Students in the major may opt for a Cyber and Artificial Intelligence track.

PROBLEM STATEMENT

Emerging AI tools, particularly large language models, have been broadly accepted in the business world, but academia has been slower to embrace them (Kingsnorth, 2023; Strain, 2024; Yudkowsky, 2023). A notable exception in the academic sector is the for-profit organization Khan Academy (Khan, 2023). This raises the question of whether AI tools are just the latest fad in infotech or whether there is a sound basis for academia's general rejection of them compared with their enthusiastic reception by for-profit entities. The study tests whether learning differences when using the popular ChatGPT tool are measurable and whether ChatGPT can accelerate student learning.

METHODOLOGY

This study compared the insights from research by four pairs of undergraduate college students at Patrick Henry College. Each pair examined the same technology and provided a technical description, example applications, moral issues, and conclusion*s* about the technology. Paper one (pre-Spring 2023) did not access or use a large language model. Paper two (Spring 2023) used ChatGPT but was limited to asking professional editing questions such as *What is missing?* and *What element requires additional work?* The Spring 2023 students ($n = 6$) were taught how to construct ChatGPT prompts and were required to use the prompts on the assignment. The four technology topics researched included exoskeletons, gene editing, automated weapons, and directed energy weapons. Student papers were assessed in a section-by-section, side-by-side comparison for relative insight advantage (see details below) in each of these technology topics, along with the number and age of the references (relative to the date of the paper) and other potential factors.

FINDINGS

Students using ChatGPT in editor mode demonstrated nearly seven times the number of insight advantages (unique results) compared to students who did not use AI tools. The insight advantages were distributed across the four topics, as shown in Figure 1.

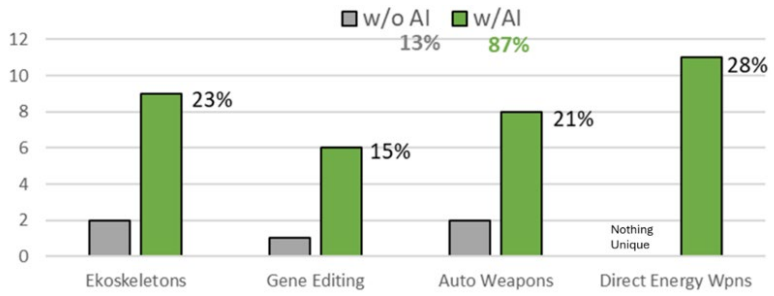

Figure 1. Relative Insight Advantage by Technology Topic

The number and relative age of sources evidenced no apparent trends or correlations between the students who used AI and the control group. If anything, the group using AI had a higher number of sources (20.3 vs. 13.8), and their dates of publication were slightly more current (relative to the date of the student paper) (2.8 years old vs. 3.4 years old). See Figure 2.

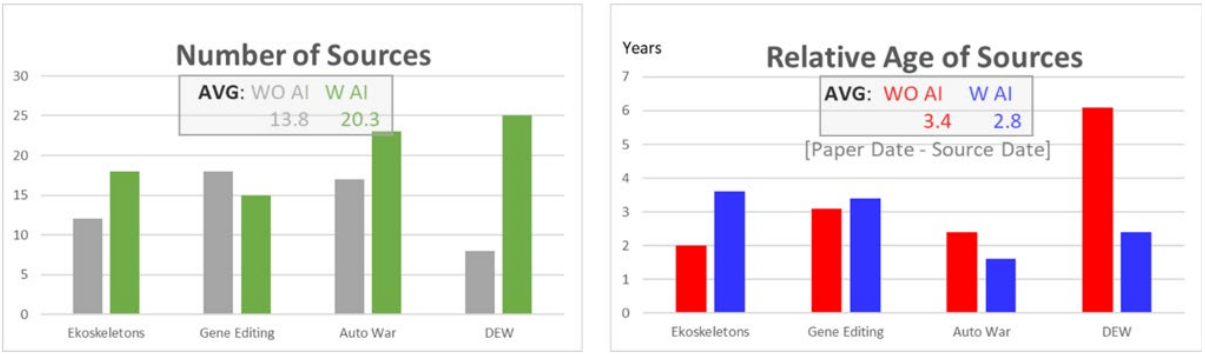

Figure 2. Number of Sources and Age of Sources

Likewise, there was no significant difference in students' cumulative grade point average between the ChatGPT and control groups. The GPA advantage was evenly split among those using the AI tools and the control group (3.38 vs. 3.4 GPA). See Figure 3.

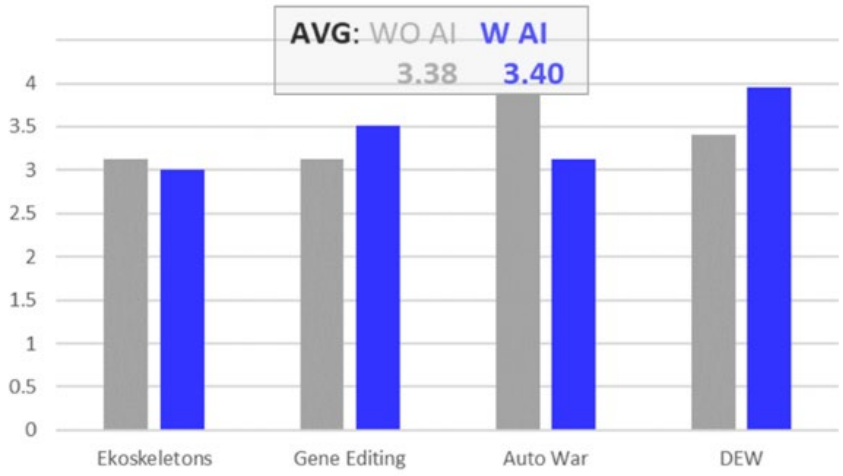

Figure 3. Student Grade Point Average

Observation 1. It is feasible to measure the acceleration of student learning through the constrained use of ChatGPT. Measurement was accomplished by inspecting and comparing applicable portions of papers side by side and counting the instances in which unique insights were cited in a student's paper (insights that did not appear in the other paired student's paper).

Observation 2. According to student data, the relative insight advantages were not associated with the number of sources cited, the age of the sources, or (perhaps unexpectedly) specific instances of the use of ChatGPT. A stark result was that specific insight advantages (accelerated learning) did not overlap with any sections in which the students modified their papers based on ChatGPT editorial feedback. This leaves the question of how students who used ChatGPT only in editor mode demonstrated substantially more insight advantages than students who did not use ChatGPT.

THEORY BEHIND THESE RESULTS

The author's working theory for these results is that providing instruction on prompt engineering, specifically instruction on formulating precise and contextualized questions, and having students practice using ChatGPT throughout the semester substantially fostered thoughtful engagement and a more assertive learning approach. This phenomenon may be explained by the nature of the prompt engineering methodology and its facilitation of student engagement with the learning elements described in Bloom et al.'s (1956) *Taxonomy of Educational Objectives*: knowledge, comprehension, application, analysis, synthesis, and evaluation.

The prompt engineering methodology used during the semester for students using ChatGPT involved an iterative development of a concise *task statement*—not just an iteration of search results—enveloped by applicable context. It also incorporated the idea that excellent prompts result from study, practice, and learning the skill of prompt formulation. Henrik Kniberg (2024) summarized these elements well (See Figure 4). Merely using AI prompt boxes as historical Google search boxes, rather than entering skillfully developed prompts, is an under-use of these new tools.

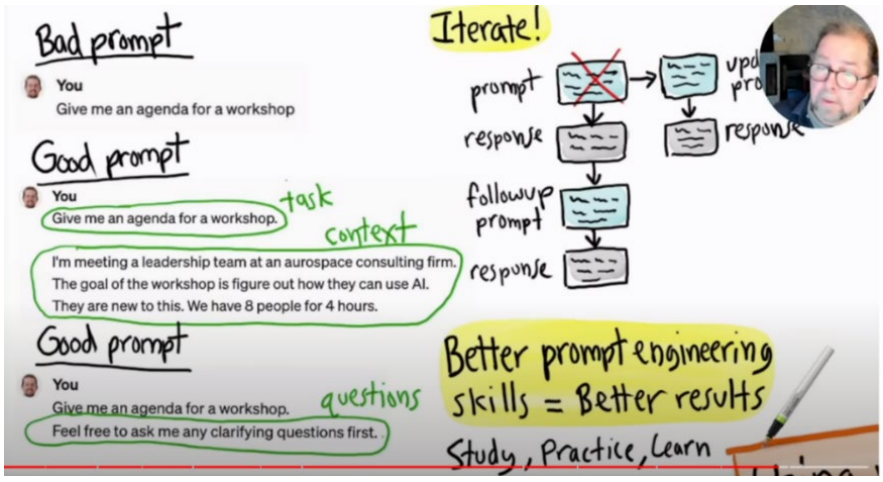

Figure 4. Generative AI in a Nutshell (Kniberg, 2024)

The prompt engineering process encouraged students to engage at the highest levels of Bloom et al.'s (1956) *Taxonomy*. The relative insight advantages they displayed in the experimental data resulted structurally from their experiences with cognitive, affective, and psychomotor learning elements rather than from individual points of feedback from ChatGPT. This was substantiated by the absence of such occurrences in the data, the class structure, and the nature of the students in this class.

The iterative nature of the prompt development and the individualized tutorial feedback from ChatGPT contributed an "x" factor, generating *human deep learning* that became embedded in students' learning values and processes. As a result, their cognitive and critical thinking skills and affective learning skills matured. Although this experiment did not specifically collect psychomotor data, students' readiness mindsets and imitative and learned responses to the prompt engineering practice likely improved alongside their ChatGPT skills and contributed to their deep learning. See Figure 5.

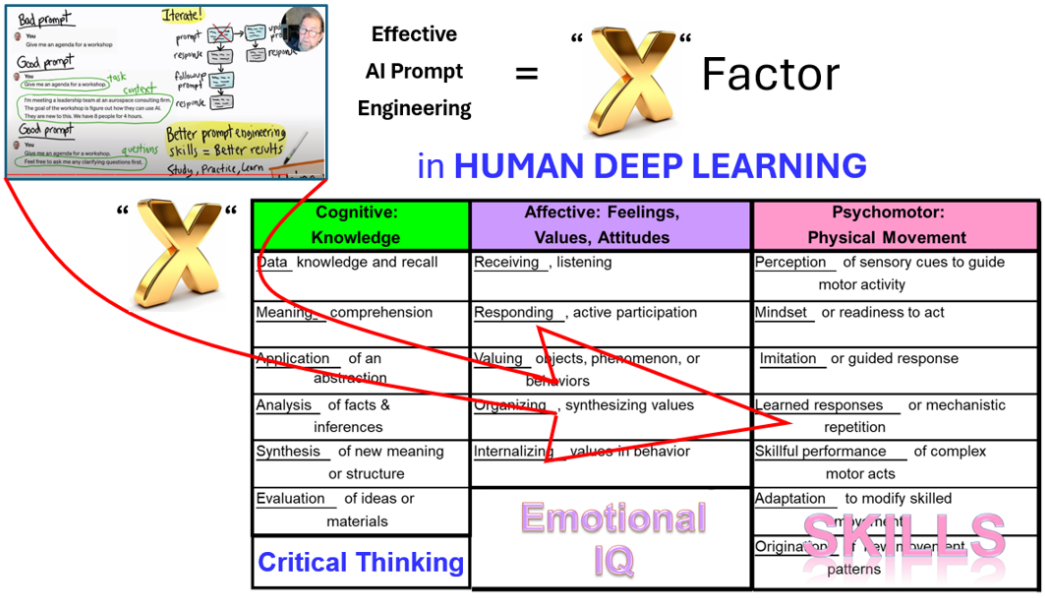

Figure 5. Prompt Engineering "X" Factor in Human Deep Learning

The "x" factor from the prompt engineering process is more than good critical thinking. It results from the Socratic iteration of the student's engagement with the AI tool. It includes the psychomotor frameworks that build up a readiness mindset to learn and search for adaptations toward learning about the subject. This mindset reinforces active listening and participation in the iterative feedback process, which generates personal valuation of learning and internalization of learning elements as outcomes of this facilitated learning process.

CONCLUSIONS AND RECOMMENDATIONS

The interactive and repetitive nature of the prompt engineering process taught to students using ChatGPT resulted in accelerated, deeper learning. This mechanism drew students into a deeper inquiry and critical thinking mode compared to the control group. The author found that the prompt engineering process facilitated deeper levels of emotional engagement and ownership of the research effort on the part of the student test group.

Students who were taught effective methods of general prompt engineering and used ChatGPT in a limited mode demonstrated notably higher numbers of insight advantages compared to students who did not use ChatGPT. Tailored prompt-engineering methods are rapidly being developed for increased effectiveness on specific data types and questions (See Democratizing Artificial Intelligence Research, Education, and Technologies, 2024). Instruction on AI prompt engineering, specifically focusing on the skill of formulating precise and contextualized questions when using ChatGPT, generated an increase in unique insights when compared with papers on the same topic from students who did not receive such instruction.

The small sample size in this study is a significant limitation. It limits the conclusions of the study to indications rather than firm conclusions for building grand implementations. Larger test groups to measure student learning must substantiate and expand upon these results. A second limitation is the qualitative nature of underlying assessments of student learning. This was moderated by enumerating relative insight advantages. Further development of metrics to assess learning effects from the use of AI tools is warranted, as are longitudinal studies to explore longer-term effects, including retention. Two other areas for further research include elements specific to AI. First, other types and techniques of prompt engineering are alluded to above, and it is possible that these may have differential effects on learning processes. The results of even this small study suggest the value of exploring the effects of other emerging techniques. Lastly, the specificity that prompt engineering allows, together with the objectivity and repeatability of AI-enabled assessments of otherwise subjective data, may offer a new category of tools to address the longstanding issue of subjective social science data. Such AI-enabled evaluation techniques might bring a new level of transparency and consistency to the social sciences.

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