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Student Performance in Writing Prompts for Text-based GenAI tools in a Research Methodology Course

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Abstract

Prompts are essential for obtaining high-quality results in interactions with Generative Artificial Intelligence (GenAI). The precision and clarity of a prompt determine the relevance and usefulness of the generated response. This article explores how undergraduate students write prompts, using text-based tools to be assisted on their research proposals (*n*= 36). The results show that the group of students only reaches the knowledge level of Bloom's taxonomy in their interactions with GenAi. It is concluded that having access to is not enough. On the contrary, it is necessary to demonstrate various generic competencies, such as analysis, decision-making, and critical thinking. Moreover, the ability to formulate effective prompts is considered fundamental for maximizing the potential of GenAI in educational contexts, suggesting the need for specific training in the creation of clear and precise prompts to improve academic performance and research quality.

Introduction

The emergence of ChatGPT and its repercussions in education and academic research mark a significant turning point in the incorporation of Artificial Intelligence (AI) in these fields. ChatGPT, launched by OpenAI on November 30, 2022, has since gone viral on social media as users share examples of what it can do. As Marr (2023) states, the stories and samples range from planning a trip to writing fables and generating computer code. Within five days, the chatbot had attracted over one million users. In different fields. For example, in higher education, students are using GenAI to help them to think of topics related to their course, list skills they might want to highlight; structure help for advice on organizing their assignments and they are also using it to review their draft to make them clearer and more straightforward.

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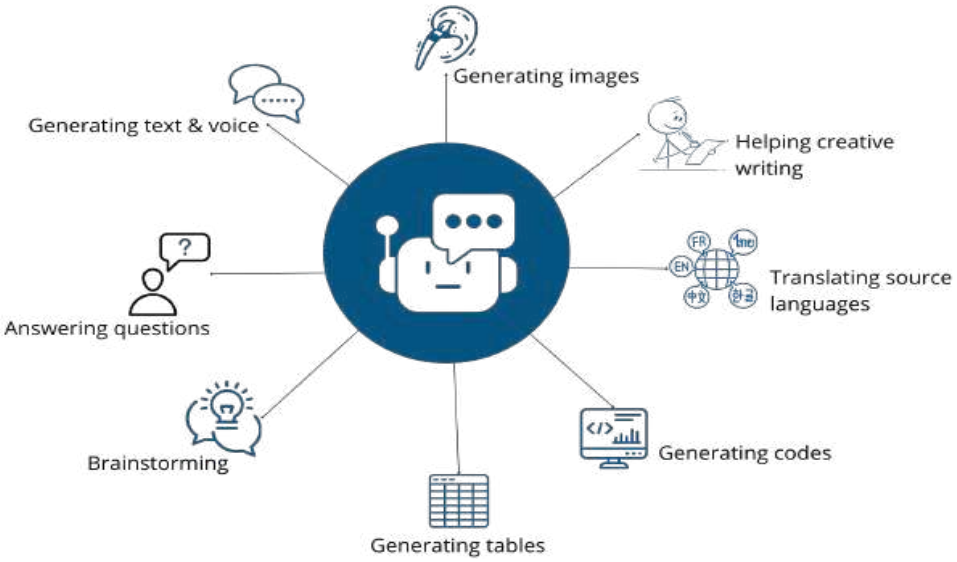
According to Liu *et al.* (2023), GENAI plays a crucial role in accelerating the Digital Transformation of Education (DTE). By leveraging its advanced capabilities in processing and understanding visual, auditory, and linguistic inputs, GenAI revolutionizes how instructors and students interact with chatbot (Figure 1). Furthermore, it enhances automation processes, enabling more efficient data analysis and decision-making. In the realm of customer service, GENAI-powered chatbots and virtual assistants provide instantaneous, personalized support, significantly improving user experience and operational efficiency.

Figure 1: Chatbot's multiple functions



Source: Own elaboration.

Specifically, ChatGPT is a pre-trained Large Language Model (LLM) that has garnered considerable attention due to its exceptional ability to generate human-like text and engage in interactive conversations (Silva & Janes, 2022; Haque *et al*., 2022; Vera, 2023a; Vera, 2024). This ability has enabled a wide variety of applications, ranging from optimizing software development processes to innovating in the fields of entertainment and creative expression (Haque et al., 2022). ChatGPT's sophisticated algorithms allow it to understand and respond to a diverse range of prompts, making it a versatile tool for various sectors (Grassini, 2023; Vera, Vera, 2023a; 2023b; Vera, 2024). For instance, in software development, ChatGPT can assist developers by generating code snippets, debugging, and even suggesting improvements. This not only speeds up the development process but also enhances the quality of the final product. In the creative industries, writers and artists are leveraging ChatGPT to brainstorm ideas, draft content, and explore new artistic expressions. This has opened new avenues for creativity and innovation, demonstrating the far-reaching potential of GENAI in transforming traditional practices.

Early adopters of this technology have described it as a disruptive force, with the potential to profoundly transform established paradigms in various sectors, particularly in education and research. In the educational field, ChatGPT and other AIs can be used as a tool to personalize learning, offering detailed and precise answers to student inquiries, which can enrich the educational process and make it more accessible (Vera, 2024). Furthermore, researchers can benefit from its ability to analyze large volumes of data and generate new ideas, thus facilitating the advancement of knowledge and innovation. In fact, AI has ushered in a new era of innovation and transformation across various sectors, including education. It provides new tools and applications capable of revolutionizing conventional teaching and learning approaches (Adiguzel *et al.,* 2023). Thus, AI's potential applications in education are extensive, ranging from enhancing productivity and learning outcomes to offering personalized instruction, instant feedback, and increased student engagement.

In educational settings, the integration of ChatGPT can lead to more tailored learning experiences. Students can interact with the AI to receive personalized feedback, explanations, and even tutoring in complex subjects. This personalized approach can cater to individual learning styles and paces, making education more inclusive and effective. For researchers, ChatGPT offers a powerful tool for literature reviews, hypothesis generation, and data interpretation. By automating routine tasks, researchers can focus on more strategic and creative aspects of their work, potentially accelerating the pace of scientific discovery and innovation.

As more Higher Education Institutions (HEI) and research centers begin to adopt this technology, it is expected that ChatGPT will continue to revolutionize the way academic teaching and research are conducted. Artificial intelligence can not only complement traditional teaching and learning methods but also introduce new ways of exploring and understanding information. Ultimately, the integration of tools like ChatGPT and other intelligent technologies could lead to greater efficiency, accuracy, and creativity in education and research, thereby redefining the boundaries of what is possible in these fields.

The adoption of ChatGPT by HEIs and research centers marks a significant shift towards embracing GenAi-driven methodologies. This transition is likely to bring about a more dynamic and interactive learning environment, where AI acts as both a guide and a collaborator. In research, the enhanced capabilities of ChatGPT could lead to more interdisciplinary collaborations and innovative approaches to problem-solving. The potential for AI to streamline administrative tasks, provide real-time insights, and facilitate complex analyses suggests a future where academic and research activities are more efficient, allowing professionals to dedicate more time to critical thinking and innovation.

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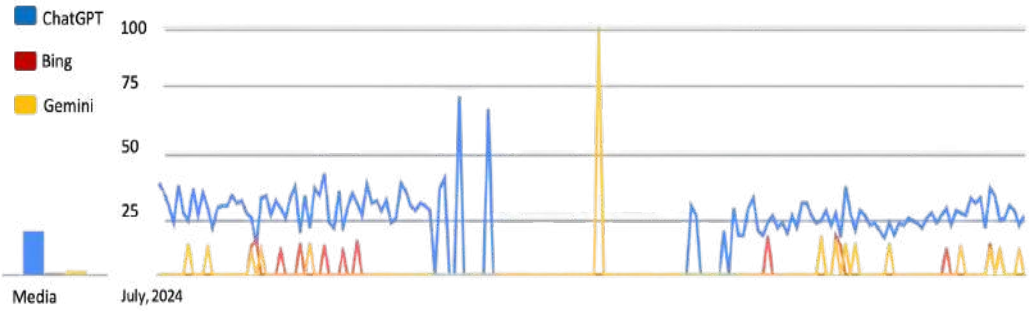
Interaction with GenAI, such as ChatGPT, Bing, Gemini, and others, has revolutionized the way humans and machines communicate (Figure 1). These systems are capable of generating coherent and relevant text in response to a wide variety of requests or "prompts." However, the quality of these interactions largely depends on how the prompts are formulated. This article explores the importance of prompts in interactions with GenAI and offers guidelines to maximize their effectiveness.

Figure 2: Search interest based on Google trends



Source: Adapted from Google trends.

The revolution brought by GenAi is rooted in its ability to understand and process natural language prompts. These prompts act as the initial input that guides the GenAI's response. The specificity and structure of a prompt can significantly influence the quality of the GenAi's output. Clear and detailed prompts enable the GenAi to generate more accurate and useful responses, while vague or ambiguous prompts can lead to less relevant outputs. This dynamic underscores the critical role of user input in harnessing the full potential of GAI technologies.

What is a prompt?

A prompt is a piece of information, question, or instruction given to a GenAI model to elicit a specific response. In the context of GenAI, a prompt serves as the input that guides the model's output. It can be a simple query, a detailed description, a sentence, or a series of instructions that the GenAI uses to generate relevant and coherent responses based on the patterns and knowledge it has acquired during its training. The quality and specificity of the prompt play a crucial role in determining the accuracy and relevance of the AI's response. Therefore, the quality of the responses you get from a GenAI tool is significantly influenced by the information, sentences, or questions you provide as input ('prompts'). Once you submit a prompt, the GenAI model processes your input and produces a response grounded in the patterns it has learned during its training phase.

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To enhance the quality of these outputs, it is beneficial to craft more detailed and descriptive prompts. Clear and specific prompts guide the GenAI to generate more accurate and relevant responses, thereby improving the overall interaction experience. Providing context, specifying the desired format, and including examples in your prompts can further refine the quality and precision of the generated content.

As you can see, prompts act as the spark that ignites the engine of artificial intelligence. By providing clear and precise information, users can guide GenAI to generate responses that are both useful and informative. A good prompt should be specific, detailed, and well-structured. Ambiguity in prompts can lead to vague or irrelevant responses, while precision and clarity can result in highly satisfactory interactions.

Undoubtedly, effective prompt formulation is a skill that requires understanding the capabilities and limitations of the GenAI. Users need to craft prompts that are not only clear but also tailored to the desired outcome. For instance, a prompt asking for a summary of a complex scientific paper should include specific details about the key points to be covered. This level of detail helps the AI to focus on relevant information, thereby producing a more accurate and valuable response.

In the educational context, well-formulated prompts can transform the way students interact with GenAI. For example, in research tasks, students can use detailed prompts to obtain precise and relevant information, thereby improving the quality of their academic work. Furthermore, educators can use strategic prompts to create interactive exercises that foster critical thinking and creativity in students. By crafting prompts that require students to engage deeply with the material, educators can help students develop a stronger understanding of complex topics. This approach ensures that students not only gather information but also learn to synthesize and apply their knowledge effectively.

In classrooms, the use of well-crafted prompts can significantly enhance student engagement and learning outcomes. Educators can design prompts that challenge students to think deeply and critically about subject matter, encouraging them to explore different perspectives and solutions. This interactive approach not only makes learning more engaging but also helps students develop essential skills such as problem-solving and analytical thinking. By promoting an environment where students actively participate and reflect on their learning processes, educators can foster a more dynamic and effective educational experience that prepares students for future academic and professional challenges.

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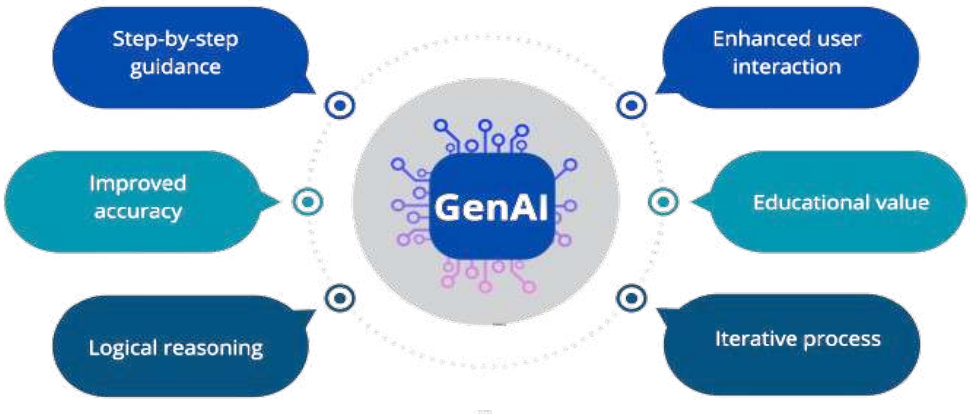
Change-of-thought prompting

Change-of-thought prompting, also referred to as CoT prompting, is a technique used in human-computer interaction, particularly in the context of GenAi and machine learning models, to guide users in refining their input queries or prompts to achieve more accurate and relevant responses. From this perspective, it causes the model to "think" in a sequential manner by processing information step-by-step (Wei *et al*., 2022; Kojima *et al.,* 2022; Lyu *et al.,* 2023; Wang *et al*., 2023). This method helps users break down complex problems into smaller, more manageable parts, enabling the GenAI to process the information more effectively.

According to Wang *et al.* (2023), a key element of a CoT rationale is its ability to demonstrate logically valid and sound reasoning. By encouraging users to think through their queries step-by-step, CoT prompting ensures that the input provided to the GenAI is clear, concise, and logically structured. This not only improves the quality of the AI's responses but also enhances the overall user experience by fostering a more intuitive and effective interaction between humans and Gen AI systems.

More specifically, CoT prompting is characterized by its structured, step-by-step guidance that helps users break down complex queries into smaller, more manageable parts, thereby improving the accuracy and relevance of AI responses. This technique emphasizes logically valid and sound reasoning, ensuring inputs are clear and logically structured. It enhances user interaction by fostering an intuitive and effective dialogue between humans and AI and serves an educational role by teaching critical thinking and precise query formulation. Moreover, CoT prompting is iterative, allowing for continuous refinement based on feedback across various domains and GenAI models, empowering users to take an active role in the interaction (Figure 3).

Figure 3: Main characteristics of CoT prompting



Source: Own elaboration.

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This method encourages users to rethink and rephrase their initial questions or instructions, thereby providing additional context or specificity that the GenAI can leverage to improve its output. By changing the thought process behind the prompt, users can help the GenAI model understand their intent better, leading to more precise and useful responses. This technique is especially useful in complex problem-solving scenarios, creative tasks, or when the initial AI-generated response is not satisfactory, as it fosters an iterative dialogue between the user and the GAI, enhancing the overall interaction and outcome. Look at these examples:

Technical problem-solving:
- **Initial Prompt:** "Explain machine learning."
- **CoT Prompt:** "Explain the difference between supervised and unsupervised machine learning, providing examples of when each type would be used."
- **Outcome:** The AI delivers a more targeted and informative response, clarifying specific concepts within the broader topic of machine learning.

Historical research:
- **Initial Prompt:** "Tell me about World War II."
- **CoT prompt:** "Describe the impact of World War II on the global economy, focusing on the reconstruction efforts in Europe and Japan."
- **Outcome:** The AI provides a focused analysis of the economic aftermath of World War II,

As you can see, when using CoT prompting, the outcome is typically a more structured, coherent, and accurate response from GAI tools. CoT prompting involves breaking down a complex query into a series of smaller, logical steps, guiding the AI through the reasoning process. This method enhances the GenAI's ability to handle intricate problems by mimicking human thought processes, leading to several key outcomes:

- *Improved clarity:* By prompting the GenAI to think through each step of the problem, the final response tends to be clearer and more detailed. The GenAI can provide a comprehensive answer that covers all aspects of the query.

- *Enhanced accuracy:* CoT prompting helps the GenAI avoid common pitfalls and mistakes by ensuring that each step is logically consistent with the previous ones. This step-by-step approach reduces the likelihood of errors and increases the precision of the response.

- *Better problem-solving:* For complex queries that require multi-step reasoning, CoT prompting allows the GenAI to break down the problem into manageable parts. This makes it easier for the AI to tackle each part effectively, leading to a well-thought-out solution.

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- *Greater insight:* By following a chain of thought, the GenAI can provide more nuanced and insightful answers. It can explain its reasoning process, which can be valuable for users who need to understand how the AI arrived at its conclusions.

Overall, CoT prompting leverages the GenAI's capabilities in a more sophisticated and nuanced manner, resulting in outcomes that are not only more accurate but also more comprehensive and aligned with the user's specific needs and expectations. By encouraging the GAI to articulate its reasoning process step-by-step, CoT prompting allows for a deeper exploration of complex topics and questions. This method ensures that the GenAI's responses are well-thought-out, logically sound, and transparent, which can greatly enhance user confidence in the GenAI's capabilities. Moreover, CoT prompting can help identify and address potential misunderstandings or ambiguities in the user's query, leading to more precise and relevant answers. In essence, CoT prompting transforms interactions with the GAI into a more collaborative and insightful experience, ultimately improving the quality and reliability of the information provided.

Personalization

Personalization is another critical aspect of prompts in interactions with GenAI. By tailoring prompts to the specific needs and contexts of users, more relevant and useful responses can be obtained. This is particularly important in fields such as medicine, where professionals can use personalized prompts to obtain detailed and specific information about treatments or diagnoses, thereby improving patient care. Thus, personalized prompts enable GAI to deliver responses that are closely aligned with the unique requirements of each user. In healthcare, this can translate to more accurate diagnoses and personalized treatment plans, ultimately leading to better patient outcomes. The ability to customize prompts also allows professionals to leverage GenAI in a way that complements their expertise, enhancing their decision-making processes and the quality of care provided.

Moreover, well-designed prompts for text-based GenAI tools can help overcome linguistic and cultural barriers. GenAI can translate and adapt content to be understandable and relevant in different cultural contexts. This opens new possibilities for global communication and international collaboration, facilitating the exchange of information and mutual understanding. Therefore, the cross-cultural capabilities of GenAI are particularly valuable in an increasingly interconnected world. By bridging language gaps and cultural differences, GenAI can facilitate more effective communication and collaboration across borders. This capability not only supports global business and academic initiatives but also promotes a deeper understanding and appreciation of diverse perspectives.

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The ability of GenAI to learn and adapt through interaction with users also highlights the importance of prompts. As users provide feedback and adjust their prompts, GenAI can refine its responses and improve its performance. This continuous feedback loop is crucial for the development and enhancement of GeAI capabilities. Thus, the iterative nature of interactions with GAI enables continuous improvement in the GenAI's performance. Users play a key role in this process by providing constructive feedback and refining their prompts based on the GenAI's responses. This ongoing dialogue between users and GenAI helps to enhance the accuracy, relevance, and overall quality of the GenAI's output, driving its evolution and effectiveness.

Additionally, GenAI often produces outcomes that appear credible, but are either inaccurate or illogical in relation to the original information source (Thiga, 2024). From this perspective, critical thinking should be developed more than ever to assess outputs that seem plausible, but are either incorrect or unreasonable with respect to the source of information (hallucinations). In this regard, the academic discourse on critical thinking should recognize the importance of questioning as a vital component (Rusdin *et al*., 2023). As it is noted, formulating good prompts is not always an easy task. It requires a clear understanding of the objective of the interaction and the capabilities and limitations of the GenAI. Users must be able to articulate their needs and expectations clearly and precisely. It is also important to consider the context in which the GenAI is used, as different situations may require different approaches in prompt formulation.

In fact, crafting effective prompts demands both skill and insight. Users need to have a deep understanding of what they want to achieve and how the GenAI can assist in that process. This involves not only knowing the strengths and limitations of the GenAI but also being able to express their queries in a way that the GenAI can interpret accurately. Therefore, crafting these prompts is crucial for ensuring effective communication and interaction with GenAI systems. They require a balance of technical accuracy and creative ingenuity (Bozkurt & Sharma, 2023; Sharma & Bozkurt, 2024). Properly constructed prompts enable the GenAI to interpret user inputs more accurately, leading to more relevant and useful responses. This blend of precision and creativity in prompt design not only enhances the functionality of GenAI, but also enriches the user experience, making interactions more intuitive and productive.

Critical thinking and CoT prompting

The relationship between critical thinking and CoT prompting is inherently symbiotic, enhancing both GenAI performance and user experience. To explore the potential of AI text generators in improving critical thinking skills, Bloom's taxonomy offers a pertinent framework for assessing educational learning outcomes. This taxonomy, as discussed in recent literature (Schoepp, 2017; Vera, 2020; Calma & Davies, 2020) provides a structured approach to evaluating how different educational tools and methods influence various levels of cognitive development.

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From this perspective, critical thinking involves analyzing and evaluating an issue deeply to form a judgment, a process that CoT prompting emulates by guiding the AI through a structured reasoning pathway. By breaking down complex queries into manageable steps, CoT prompting encourages the GenAI to think critically, mirroring the human process of dissecting problems to arrive at well-supported conclusions. This structured approach not only leads to more accurate and comprehensive responses but also fosters a deeper understanding of the subject matter, as the GenAI can systematically address each component of the query.

In this regard, CoT prompting acts as a catalyst for critical thinking within the AI, refining its ability to generate logical, coherent, and insightful responses. Thus, inndividuals with well-developed critical thinking skills are not only capable of addressing problems beyond GenAI's reach, but they are also better prepared to effectively use AI to enhance their own abilities, refine AI's outcomes and identify malicious actor (Carucci, 2024). Moreover, the integration of critical thinking into CoT prompting enhances the transparency and reliability of AI outputs. When the GenAI articulates its reasoning process step-by-step, users can follow the logical progression of thought, making it easier to identify any potential errors or biases. This transparency builds trust, as users can see how conclusions are drawn, ensuring that the GenAI's responses align with rigorous standards of critical thinking.

Additionally, CoT prompting helps the AI to better understand and address the nuances of user queries, as it must consider various angles and implications during its reasoning process. This depth of analysis not only improves the relevance and precision of the GenAI's answers but also empowers users to engage more critically with the information provided. Ultimately, the interplay between critical thinking and CoT prompting fosters a more intelligent, reliable, and user-centric GenAI experience.

Method and Materials

This study utilizes a descriptive qualitative research methodology to examine the extent of students' critical thinking skills as reflected in their writing, with a particular focus on their capacity to craft high-quality prompts for text-based GAI. This approach aligns with the perspective, which highlights the use of descriptive qualitative methods to s to obtain, analyze, and interpret the data content analysis of visual and textual materials, and oral history (Zohrabi, 2013). Specifically, qualitative research delves into the connections, events, and situations that shape these elements, providing a comprehensive understanding of their benefits. It also allows researchers to delve into the thoughts and emotions of participants, facilitating a deeper comprehension of the significance individuals attach to their experiences (Sutton & Austin, 2023).

By focusing on students' ability to craft high-quality prompts, this study aims to illustrate how GAI can serve as a valuable tool in research projects, provided that students exhibit high levels of critical thinking, especially in formulating research questions and objectives. This approach not only enhances the precision and effectiveness of GAI-generated content but also fosters the development of students' critical thinking and analytical skills. Ultimately, the research underscores the importance of integrating GenAI into educational practices to support and advance students' proficiency in writing and research

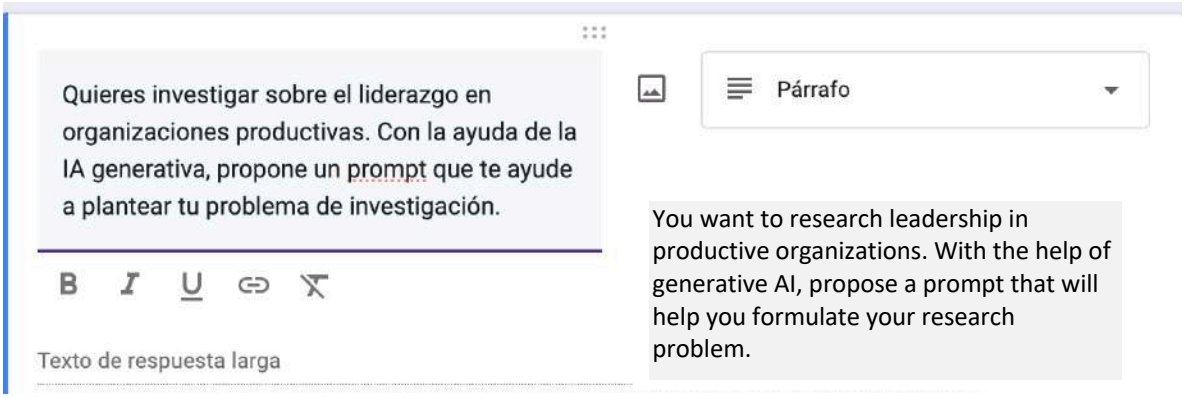
Participants

The sample consists of 36 undergraduate Nursing students enrolled in a Research Methodology course at a private Chilean university. The sample includes 8 males and 28 females (22% and 78%, respectively), with an average age of 26 years (SD = 2.2). These students face comprehension challenges and are accustomed to traditional, behaviorist-style classes. However, the instructor employed a constructivist approach in this course.

Instrument

As a methodological strategy, the following challenge was presented: *"You want to research leadership in productive organizations. With the help of GenAI, propose a prompt that helps you formulate your research problem".* To collect the prompts, a QR code linking to a Google Forms survey was shared, which contained this single instruction as the challenge (Figure 4). Immediately after the experience, the instructor provided feedback based on strategies for formulating a research problem and advice on using GenAI effectively. It is important to highlight that the students in this group were asked to work individually for 5 minutes.

Figure 4: Students' challnge in Google Forms



Note: The text on the right is the English version of the students' challenge.

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To ensure student participation, this experience - focused on the creation of prompts for interacting with GenAI - was conducted during regular class hours. Additionally, students were asked to imagine that they were interacting with a GenAI of their preference. Conducting the activity within the standard class schedule was crucial in maximizing engagement, as it allowed students to seamlessly integrate this innovative exercise into their daily routine. By embedding the activity into the typical class structure, students were more likely to view it as an integral part of their learning process rather than an additional task. This approach not only facilitated active participation, but also ensured that students could apply their new skills immediately in a familiar educational setting, thereby enhancing their overall learning experience.

It is important to highlight that the translation of the selected prompts into English was performed using ChatGPT, a large language model trained by OpenAI (OpenAI, 2024). This ensured accurate and nuanced translations, maintaining the integrity and intent of the original inputs. The use of Google Forms facilitated the quick collection of prompts from this group of students. It also allowed for timing the proposed challenge.

Results

In-situ observation

During this activity, the instructor observed that some students did not follow the instructions to work individually, without the aid of any electronic devices. Additionally, a lack of concentration and a desire to finish as quickly as possible were noted. In fact, most of the students in this group took less than the five minutes allocated to complete this task. The instructor's observations highlighted several key issues, including the students' reliance on external aids and their difficulty in maintaining focus during individual work. This raises concerns about their ability to work independently and suggests a need for strategies to improve concentration and adherence to instructions. These findings will be crucial for developing future instructional approaches to enhance individual work skills and overall classroom discipline.

The following are some prompts submitted by this group of students to request assistance from GAI for a hypothetical research problem.

- *Hello, I am a student who wants to start research on leadership in productive organizations in Chile. I would like some ideas on how to formulate my research problem, so I can choose the one that seems best and proceed with my research*. (Student4)
- *Hello Claude, I am researching leadership in productive organizations. Could you help me formulate a relevant and current research problem on this topic? Please include: a concise problem description, relevance and importance of this topic, two or three specific research questions, and possible methodological approaches to address this problem.* (Student10)

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- *Hello, I need help to formulate the following research topic. Please provide some examples. Research topic: Leadership in productive organizations.* (Student15)
- *How do different leadership styles impact the productivity of organizations? Specifically, how do transformational, transactional, and laissez-faire leadership styles influence key performance indicators (KPIs) in productive organizations?* (Student21)
- *Hello, I am a university student and I need to conduct research on leadership in productive organizations.* (Student28)

- *Good morning, I am a second-year nursing student, and I am conducting research on leadership in productive organizations. Could you help me with information on the impact of productive organizations on individuals and any studies that support this issue?* (Student32)

Student performance

To facilitate content analysis, the following dimensions were defined: Contextualization, User intent, Role assignment and Critical thinking.

Contextualization

This dimension involves providing background information or context for the prompt. It helps to frame the situation, giving the GenAI a better understanding of the environment, subject matter, or scenario it needs to consider. By doing so, it seeks to ensure that the GAI has enough information to generate responses that are relevant and appropriate to the given situation. This contextualization is essential for setting the stage for the AI's response, making it more aligned with the user's needs. When prompts are well-contextualized, the AI can deliver more precise and tailored outputs. The results are as follows:

The majority of these students (85%) provided moderate contextualization in their prompts, indicating a weak understanding of the importance of setting the scene for GenAI interaction. This demonstrated their unawareness of providing a clear framework within which the GenAI could operate, making the prompts relevant and situationally appropriate. Additionally, a significant shortfall was observed in the depth and detail of the data provided within these prompts. This lack of comprehensive context limited the effectiveness of GenAI, as it relied heavily on detailed and specific information to generate accurate and relevant responses. Consequently, students missed out on fully leveraging the potential of GenAI to enhance their research and inquiry processes.

In general, many students tended to offer general contexts without delving into specific nuances or intricate details necessary for the GenAI to generate precise and tailored responses. This lack of detailed data limited the GenAI's ability to fully comprehend the unique aspects of each scenario, resulting in responses that might not entirely meet the students' expectations. For example, while a student might have effectively established a scenario about researching leadership in productive organizations, they often failed to specify which aspects of leadership or productivity

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they were focusing on. Consequently, the GenAI's outcome could be too broad or vague, failing to address the precise needs of the task.

User intent

This dimension focuses on clearly stating the desired outcome or objective of the interaction with the AI. It involves specifying what the user wants to achieve or obtain from the GenAI's response. It seeks to help the GenAI to understand the user's goals and tailor its responses accordingly. By knowing the user's precise intent, the GenAI can provide more targeted and useful answers, enhancing the overall effectiveness of the interaction. The results are as follows:

A significant proportion of students (65%) specified the outcomes they sought from their interactions with GenAI. This indicated a commendable level of clarity and purpose in their approach, as they articulated their expectations and desired results from the GenAI's responses. It is important to highlight that by clearly defining our goals, we enable the GenAI to concentrate its processing power on delivering targeted and relevant outputs, thereby enhancing the overall efficiency and effectiveness of the interaction.

However, there is still room for improvement in this area. While these students specified their desired outcomes, the specificity and detail of these requirements often varied. For example, a student might have requested assistance in formulating a research question on leadership in productive organizations but did not outline the specific criteria or dimensions they wished to explore, such as ethical leadership, impact on employee morale, or quantitative metrics of productivity. This lack of detailed guidance can lead to responses that, although aligned with the general outcome, may not fully address the specific needs or expectations of the student.

Role assignment

This dimension involves assigning a specific role or perspective to the GenAI, guiding it on how to approach the problem or request. It could mean asking the GenAI to respond as an expert in a particular field, a tutor, a researcher, etc. It seeks to help in shaping the GAI's response style and content, making it more relevant to the user's expectations. By defining a role, users can leverage the AI's capabilities more strategically, ensuring that the responses are not only accurate but also presented in the most useful manner for the given context. The results are as follows:

One notable gap in the students' approach to interacting with GenAI was the absence of assigning specific roles to the GenAI. None of the students in the observed group incorporated this technique, which could significantly enhance the quality and relevance of the GenAI's responses. Assigning a role to the GenAI can help contextualize its output, making the interaction more focused and tailored to the student's needs.

For instance, if a student is working on a research project, they might assign the AI the role of a research assistant, which would prompt the GenAI to provide more structured and academically

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rigorous responses. Alternatively, for creative writing tasks, assigning the role of a creative writing coach could lead to more imaginative and stylistically nuanced suggestions. By clearly defining the role, students can guide the GenAI to produce responses that are better aligned with their specific objectives, thereby improving the overall efficacy of the interaction.

When students do not assign a role, the GenAI is left to interpret its function based on limited context and specified outcomes. This can lead to responses that are general or not fully aligned with the student's expectations. For instance, if a student is researching leadership in productive organizations, they might receive a broad overview rather than targeted insights from the perspective of a specific role, such as a consultant, a manager, or a researcher.

By assigning a role to the GenAI, students can guide the GenAI to provide responses that are more relevant and detailed. For example, if a student assigns the role of a "research advisor" to the AI, the AI could tailor its responses to include detailed research methodologies, relevant theories, and potential sources. Similarly, assigning the role of a "research consultant" could yield practical strategies and case studies that directly apply to leadership in productive organizations.

Encouraging students to incorporate role assignment into their prompts can lead to more nuanced and applicable outcomes. Assigning a role helps the GenAI understand the specific perspective it should adopt, refining its responses to better meet the student's needs. For example, a student might ask the AI to respond as a historical figure, an expert in a particular field, or a peer reviewing their work. This approach not only makes the interaction more efficient but also enhances the educational value by providing more contextually appropriate information. Consequently, students gain more relevant insights, making their learning experience richer and more tailored to their academic goals.

Critical thinking

his dimension involves analyzing, evaluating, and synthesizing information in a logical and reflective manner. It goes beyond the simple acquisition of facts and requires individuals to engage in deep reasoning to form judgments and make decisions. Critical thinking entails questioning assumptions, identifying biases, and considering alternative perspectives to arrive at well-founded conclusions. It encourages a thorough examination of evidence and the relationships between different pieces of information. Developing these skills is essential for problem-solving and informed decision-making. The results are as follows:

The students' level of critical thinking related to interacting with GenAI shows both strengths and areas for improvement. They demonstrate an initial understanding of how to engage with the AI by contextualizing their prompts and specifying desired outcomes, indicating a foundational level of critical thinking. However, the depth and sophistication of their critical thinking can be further developed.

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Many students (85%) demonstrated proficiency in contextualizing their prompts by providing detailed background information, which significantly aids the AI in understanding the context of their inquiries. This ability to frame questions within a relevant context is a crucial component of critical thinking, reflecting their skill in identifying and articulating the broader situation or problem they are addressing. By effectively communicating these contexts to Generative AI, students show they can link their questions to specific scenarios or issues, thereby enhancing the relevance and accuracy of the AI's responses. This skill is essential for maximizing the effectiveness of AI tools in various academic and professional applications.

Additionally, 65% of these students clearly specified the outcomes they desired from their interactions with Generative AI. This illustrates a notable degree of foresight and planning, as these students are able to articulate their goals and identify the type of information or assistance they need. This skill is fundamental to critical thinking, as it involves setting precise objectives and anticipating the kind of support required to meet those objectives. By defining their desired results and communicating them effectively, students can enhance the relevance and utility of the AI's responses, ultimately leading to more targeted and successful problem-solving.

However, none of the students assigned specific roles to the GenAI, which reveals a gap in their critical thinking process. Assigning roles could significantly enhance the relevance and precision of the AI's responses by providing a specific perspective or expertise from which to generate answers. This indicates that while the students have a foundational understanding, they may not fully appreciate the strategic value of this technique in refining their queries and improving the quality of the responses.

The lack of role assignment suggests that students are not yet fully leveraging the potential of the GenAI to provide tailored, contextually appropriate insights. This aspect of critical thinking—anticipating how different roles or perspectives might influence the information provided—remains underdeveloped. Encouraging students to think critically about the role they want the GenAI to play can lead to more precise and useful interactions, ultimately enhancing their research and problem-solving capabilities.

Overall, while the students exhibit some critical thinking skills in their interactions with GenAI, there is significant room for growth. Currently, their prompts are fairly basic and lack depth in terms of extracting comprehensive and relevant information from GenAI. By incorporating more advanced techniques, such as role assignment, students can markedly improve the quality and relevance of the information they receive. Specifically, role assignment helps contextualize the AI's responses, thereby making them more precise and tailored to the specific needs of the student.

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Consequently, this progression will not only enhance their current academic projects but will also prepare them for future professional challenges. Developing these skills reflects a higher level of critical thinking and strategic inquiry, enabling students to leverage GenAI tools more effectively. Ultimately, by honing their ability to interact with GenAI, students can become more adept at integrating technology into their work, thereby leading to more innovative and insightful outcomes.

Conclusions

These students exhibit a low level of critical thinking in their interactions with GenAI, as evidenced by their inability to effectively contextualize prompts and specify desired outcomes. To compound this situation, the lack of role assignment indicates a gap in their understanding and application of advanced AI interaction techniques. This shortfall suggests that while students can frame and articulate their queries effectively, they may not fully leverage the GenAI's potential to provide tailored, contextually appropriate responses.

Enhancing critical thinking skills will be essential for fully leveraging Generative AI (GenAI) tools in both academic and professional environments. Developing these skills allows users to more effectively analyze and interpret information generated by AI, ensuring that their use of these tools is both purposeful and impactful. This underscores the importance of targeted training and increased awareness to address existing gaps in critical thinking capabilities. By focusing on these areas, individuals can improve the effectiveness of AI-assisted research and problem-solving, ultimately leading to more insightful and reliable outcomes in their work. Investing in skill development will help users make the most of AI innovations.

Another conclusion is that, when issuing a text-based prompt, this group of students does not make conceptual connections with their prior knowledge in order to enhance their inputs. This suggests that students might struggle to integrate new information with what they already know, potentially limiting the depth and relevance of their responses. Without bridging gaps between existing knowledge and new prompts, their ability to produce insightful and well-informed contributions could be compromised. Addressing this issue might involve strategies to help students link new information to their existing knowledge base more effectively.

Additionally, the fact that 65% of these students could specify their needs as outcomes from AI interactions demonstrates a promising starting point. However, it also underscores the necessity for a more robust framework that encourages comprehensive engagement with GenAI systems. The ability to specify outcomes should be complemented with a deeper understanding of how to manipulate GenAI parameters and prompts to yield the most relevant and useful information. This holistic approach to AI interaction will not only enhance the students' research capabilities but also prepare them for future technological advancements where AI's role in decision-making and information retrieval is likely to expand.

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Recommendations

To address the identified gaps, it is recommended that students receive targeted training on advanced GAI interaction techniques, including the strategic assignment of roles to the GenAI of their choice. Specifically, instructors should incorporate specific modules that emphasize the importance of role assignment in improving the relevance and precision of GenAI responses. Moreover, practical workshops and examples demonstrating how different roles can influence outcomes will help students appreciate the value of this technique. Additionally, fostering a mindset that encourages deeper critical thinking and strategic inquiry will further enhance their ability to utilize AI tools effectively.

Moreover, it is crucial to integrate these GenAI training modules into the existing curriculum to ensure that students consistently apply these techniques in various contexts. By providing ongoing support and feedback, educators can help students refine their AI interaction skills over time. Additionally, creating a collaborative learning environment where students can share their experiences and insights will further reinforce these concepts and promote peer learning. By implementing these recommendations, educational institutions can better prepare students to harness the full potential of GenAI, ultimately leading to more effective and insightful research and problem-solving capabilities. This comprehensive approach will ensure that students are not only proficient in using GenAI tools but also adept at leveraging these technologies to achieve their academic and professional goals.

Furthermore, it is essential to integrate more active learning strategies into all courses within the professional training program. This involves incorporating hands-on activities, collaborative projects, and real-world problem-solving exercises that engage students in a more dynamic and participatory learning process. By embedding active learning approaches into the curriculum, students will not only develop a deeper understanding of the material but also enhance their ability to apply knowledge in practical settings. This integration will support the development of critical thinking skills and improve overall learning outcomes, ensuring that students are well-prepared to tackle complex challenges in their future careers.

Additionally, it is crucial to provide comprehensive training for instructors in the effective use of GenAI tools. Teachers should be equipped with the skills to integrate these tools into their teaching practices and to utilize them in ways that enhance learning outcomes. Professional development programs should include training on how to effectively incorporate GenAI tools into lesson plans, assess their impact on student learning, and adjust teaching strategies based on data insights from these tools. By empowering educators with the knowledge and skills to leverage GenAI technologies, educational institutions can ensure that both students and teachers are able to fully benefit from these advancements.

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