Research Square

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A Program Evaluation for Teaching AI Prompt Engineering for Evidence-Based Medicine to Fourth Year Medical Students

Erik Langenau

ErikLa@pcom.edu

Philadelphia College of Osteopathic Medicine

Hsinliang Chen

Philadelphia College of Osteopathic Medicine

Research Article

Keywords: Artificial Intelligence, Prompt Engineering, Evidence-Based Medicine, Medical Students

Posted Date: March 27th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-8927994/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Prompt engineering is an emerging competency in medical education, essential for applying large language models (LLMs) to evidence-based medicine (EBM). This study evaluates an instructional approach designed to introduce medical students to two prompt engineering frameworks using a closed AI-assisted interdisciplinary database to answer clinical questions.

Methods

Nineteen fourth-year medical students participated in three 45-minute, one-on-one individualized sessions facilitated by faculty. Students were trained to construct AI prompts using PICO (Patient, Intervention, Comparison, Outcome) and CLEAR (Concise, Logical, Explicit, Adaptive, Reflective) frameworks within Scopus AI. Effectiveness was measured through weekly evaluations and end-of-program structured group interviews.

Results

All students completed the 3-part program. Mean confidence in prompt generation was high throughout the program: 1.16 for week one, 1.32 week two, and 1.05 week three (1 = Strongly Agree, 4 = Strongly Disagree). Students preferred the PICO framework for clinical use, finding it more straightforward and applicable for quick searches than CLEAR. Scopus AI was specifically valued for providing credible, verifiable, and peer-reviewed references compared to other open general AI tools such as ChatGPT.

Conclusion

Brief, individualized instruction is an effective model for teaching AI literacy and prompt engineering, though scaling requires balancing faculty time with educational value. Utilizing a closed AI system helps mitigate inaccuracies while enhancing student confidence in EBM application. This 3-part one-on-one curriculum provided a viable framework for integrating prompt engineering into fourth-year medical student clinical rotations to support evidence-based, point-of-care clinical decisions.

Background

Evidence-Based Medicine (EBM) is a framework for clinicians to use current evidence in making decisions about the care of patients by integrating clinical expertise, patient disposition and values, and best available research evidence.[1,2] EBM education focuses on teaching clinicians critical review of literature, research design, and application of evidence to patient care.[3] EBM is taught to medical

students, residents and practicing physicians through various methods, including research courses, workshops, journal clubs, peer review, and clinical application.[4] The PICO (Patient, Intervention, Comparison, Outcome) framework serves as a valuable tool in framing clinical questions and guiding evidence-based research.[5] Although the PICO framework maintains the reputation as a strong EBM strategy, other models, including unstructured and AI-enhanced searches, might generate similar results.[6]

Especially with the expanded use of natural language processing (NLP) with large language models (LLMs) such as ChatGPT or Google Gemini, physicians and health science students use AI-enhanced technologies to enhance learning, patient care and research.[7] Although the use of LLMs can increase medical research efficiency and clinical reasoning, there are a number of pitfalls to consider including privacy, ethics and data accuracy.[7,8] Data accuracy can be influenced by hallucinations, bias amplifications, and misinformation.[7,8] When information used to train the LLM is accurate, the output it generates is also more accurate. Scopus AI is an AI-enhanced database to help researchers by using Elsevier's trusted content from peer-reviewed journals, textbooks and publications.[9]

Prompt engineering is becoming an important competency in medical education, allowing students to implement AI technology to improve patient care.[10,11] Various frameworks, such as the AI PROMPT and PROMPT+ frameworks, provide guidelines for effective prompt engineering.[12] The CLEAR framework (Concise, Logical, Explicit, Adaptive, Reflective) offers a contemporary approach to prompt engineering with the benefits of flexibility, ease of use, and generalizability.[13,14] These frameworks allow students to create well-constructed prompts, producing accurate and evidence-based responses. Students learn about prompt engineering through a combination of practical assignments, self-paced courses, interactive learning environments, and professional training programs.[13,15,16] As an example, educators developed a self-paced course to teach prompt engineering to university students with LLMs to enhance academic English proficiency.[16]

Many reports highlight the importance of training healthcare professionals to enhance their understanding of generative AI and prompt engineering.[7,8,10,12,15,17–20] Medical schools have begun implementing AI into the formal curriculum with topics such as fundamentals of AI systems, strengths and limitations, ethical concerns, applications in healthcare settings, and critical appraisal of AI systems.[19] A small number of studies have investigated instructional approaches to teach prompt engineering skills to students in courses such as chemistry,[21] physics[22] and business.[23] However, few studies have specifically investigated instructional methods to teach these prompt engineering skills to medical students.[17] Using Scopus AI, we describe an individualized educational program to introduce prompt engineering strategies to fourth year medical students during their family medicine clinical rotation. The purpose of this study is to describe and evaluate an instructional approach for introducing medical students to two generative AI prompt engineering frameworks (PICO and CLEAR) and Scopus AI

when applying principles of evidence-based medicine to clinical questions. The findings will provide insights to enhance teaching of information literacy instruction and prompt engineering.

Methods

The primary objective of this study was to describe and evaluate a novel instructional approach for introducing fourth-year medical students to generative AI prompt engineering within the context of evidence-based medicine (EBM).

Study Design

The present study employed a mixed-methods approach to evaluate a new AI-integrated curriculum. This study utilizes the same procedural framework introduced in Chen & Langenau.[24] However, the two inquiries are distinct in scope and application. While the previous work analyzed the technical relationship between prompt engineering inputs and AI-enabled outputs,[24] the present study focuses on the instructional design, pedagogical implementation, and program evaluation within a medical student cohort. This educational program evaluation included three analyses: course participation, individual weekly assessment and evaluation, and structured group interviews.

Sample

The study sample included 19 fourth-year medical school students who completed their Family Medicine rotation at one of three primary healthcare centers within a university-based healthcare system (8 at the university practice, 5 in North Philadelphia, and 6 in West Philadelphia). Training sessions were facilitated by two professors (Pediatrics and Library Science), each with more than 20 years of experience in education, instructional design, educational technologies, literature reviews, and EBM.

Instructional Program Description

The educational program consisted of three 45-minute individualized one-on-one sessions. Students scheduled the three individual 45-minute sessions with one of two facilitators. Each session was conducted online using Google Meet and included an orientation to Scopus AI, an instructional activity (video or website review, followed by an illustration with a sample case), weekly assignment, and teaching points review (Table 1, Supplement A).

For each weekly assignment, students were asked to create a prompt based on the presented scenario. They then reviewed the Scopus AI output with their respective facilitator and completed the online assessment and evaluation. At the end of each session, the facilitator then highlighted important teaching points for the week. Week one served as an introduction to Scopus AI, as well as application to evidence-based medicine. Weeks two and three served as introductions to PICO and CLEAR prompt engineering frameworks.

[Insert Table 1 about here]

Table 1
Weekly Instruction Summary

Week	Group[a]	Theme	Instructional Activities	Assignment Scenario	Teaching Points
One	1 & 2	Scopus AI, EBM	Scopus AI Orientation Sample Case: student choice	Diabetes[c]	● Scopus AI is a research tool to help you collect information using Elsevier's resources. ● Prompt engineering is the term we use to describe the EBM question you pose. The quality of the question you pose will inform the quality of the response. ● We'll be reviewing tips to improve your prompt engineering skills over the next three weeks.
Two	1	PICO	Constructing a Search Strategy, PICO Sample Case: ADHD[b]	Diabetes[c]	● PICO is a traditional model to investigate clinical topics. It has been used for years to help clinicians with EBM searches. ● PICO components include (1) Patient or Population, (2) Intervention, (3) Comparison or Control and (4) Outcome
	2	CLEAR	Constructing a Search Strategy, CLEAR Sample Case: ADHD[b]	Diabetes[c]	● CLEAR is a contemporary model for prompt engineering. There are many other models, but this one is particularly helpful with AI searches. ● Skill comes with practice ● CLEAR components include (1) Concise, (2) Logical, (3) Explicit, (4) Adaptive, and (5) Reflective
Three	1	CLEAR	Same as above	Post-Operative Pain[d]	Same as above
	2	PICO	Same as above	Post-Operative Pain[d]	Same as above

[a] Students from each rotation site were randomly assigned to one of two facilitators.

[b] Sample ADHD Case: A 10-year-old child with ADHD is struggling academically, and their parents are asking about the effectiveness of behavioral therapy versus medication.

[c] Diabetes Case. A female patient with a Hb A1C level of 7.5%. She is 51 years old with a BMI of 32. She is a Septa driver, eats fast food once a day, and admits she rarely eats vegetables. She is interested in losing weight and controlling her newly diagnosed diabetes. She hopes to avoid medication and wants some advice. She wants to know if lifestyle changes can work.

[d] Post-operative pain management Case. A 17-year-old girl is discharged from the hospital after surgery to repair her compound femur fracture. She has a history of substance use disorder (marijuana) and wants to avoid opioids. She wants to know if she “needs” opioids or will NSAIDs work for her pain.

Course participation and engagement

All students scheduled their own 45-minute sessions with their randomly assigned facilitator who provided more than 30 options each week using Google Booking Page. Attendance was taken for each session by the facilitator who met with each student one-on-one.

Individual weekly assessment and evaluation

At the end of each weekly session, students completed the 11-item individual weekly assessment and evaluation (Supplement B), which was shared as a Google Form. This online survey provided students the opportunity to (1) critically evaluate their prompt and the Scopus AI output it generated and (2) provide feedback regarding the session.

Data from the weekly assessment surveys were extracted from Google Forms using MS Office Excel, which was used to analyze descriptive statistics, primarily frequency counts and percentages. For responses to open-ended questions, qualitative data from three successive sessions were analyzed using a thematic analysis approach with a systematic, multi-step process: two research team members independently reviewed transcripts to generate initial codes, reconciling any discrepancies through discussion to establish a shared codebook. To ensure methodological rigor, all generated themes and classifications were iteratively reviewed, refined, and validated independently by the two researchers to align with the raw survey responses.

Structured group interviews

At the completion of the program, each student was invited to participate in one of two optional online structured group interviews to debrief and provide program feedback (Supplement C).

Ethics Approval

Students completed the three 45-minute training sessions as part of their requirement for the rotation. As part of the post-rotation evaluation, all were invited to voluntarily participate in the final group discussion for which verbal informed consent to participate was given. A $50 gift card was offered to those who successfully completed the entire program and the large group discussion. At the conclusion of the rotation, this study (program evaluation) was reviewed and approved as a secondary analysis,

exempt from informed consent by the Philadelphia College of Osteopathic Medicine (PCOM) Institutional Review Board (Protocol #H25-028X). The study was conducted in accordance with the Declaration of Helsinki.

Results

Course participation and engagement

All students (19) completed all three sessions. Since students scheduled sessions themselves, only a small number of “no shows” required rescheduling.

Individual weekly assessment and evaluation

All students completed the weekly assessment and evaluation at the end of each session. Each responded to 7 Likert-type survey questions and 4 open-ended questions (Tables 2 and 3).

[Insert Table 2 about here]

Table 2
Student Responses to Weekly Evaluation

Question (1 = strongly agree; 4 = strongly disagree)	Mean Response Rating		
	Session 1	Session 2	Session 3
1. I am confident in my ability to generate prompts	1.16	1.32	1.05
2. The session was valuable.	1.05	1.05	1.05
3. I would recommend this session to other students.	1.00	1.00	1.05
4. The session was facilitated well.	1.00	1.00	1.00
5. The summary is helpful for treating the patient.	1.05	1.00	1.05
6. The key takeaways are helpful for treating the patient.	1.05	1.00	1.05
7. The top 10 references are helpful for treating the patient.	1.21	1.21	1.21

Question (Open-Ended)	Session 1	Session 2	Session 3
8. Point out the most useful reference	All identified at least one	All identified at least one	Nearly all identified at least one; one stated “not listed”
9. Point out the missing references if any	None identified	None identified	Most identified none. Two provided missing reference details.
10. Check any additional feature on SCOPUS AI that looks interesting and give your feedback	Concept Mapping (9) Expanded summary (4) Emerging Themes (2) Go Deeper (2) Topic Experts (1) References (1)	Concept Mapping (5) Expanded summary (4) Emerging Themes (2) Go Deeper (2) Summary Section (2) Summary Table (2) None or NA (2)	Concept mapping (2) Expanded summary (2) Emerging Themes (3) Go Deeper (3) Topic Experts (1) Summary (2) Hyperlinks (1) Chart/tables (3) None or NA (2)
11. Please share one important take home point you learned from today’s session.	Summarized in Table 3	Summarized in Table 3	Summarized in Table 3

At the end of each 45-minute one-on-one facilitated session, each student completed a weekly evaluation for sessions 1, 2 and 3. Responses to questions 1–7 were rated using a 4-point Likert-type scale (1 = Strongly Agree; 4 = Strongly Disagree). Reponses to questions 8–11 were open-ended.

[Insert Table 3 about here]

Table 3
Summary of Key Instructional Takeaways Identified Through Weekly Evaluations

Overarching Theme	Session 1: Awareness	Session 2: Increasing Proficiency	Session 3: Increasing Proficiency
Clinical Utility	Prompt engineering can be used for general patient education and basic queries.	Prompt engineering can be applied to specific patient factors and care planning.	Scopus AI output can be used to guide diagnosis, compare treatment modalities, and identify unforeseen risks.
Trust & Credibility	Scopus AI is more trustworthy than other "open-access" AI tools.	Students appreciated the trustworthiness of results generated via structured PICO questions.	Scopus AI output allows for critical appraisal of medical data pulled from various reputable resources.
Workflow Efficiency	Scopus AI allows for rapid access to evidence-based summaries.	Scopus AI decreases "search fatigue" by avoiding manual sifting of individual articles.	Scopus AI produces rapid results in generating concise, tailored prompts using the CLEAR/PICO models.
Frameworks & Logic	Prompt engineering and Scopus AI are good for general information gathering.	PICO is a valued model for structured questioning.	PICO is easier to understand, memorize and use, compared to CLEAR.

At the end of each 45-minute one-on-one facilitated session, each student completed a weekly evaluation, including the last open-ended question: Please share one important take-home point you learned from today's session. Qualitative data from three successive sessions were analyzed using a thematic analysis approach with a systematic, multi-step process. The above themes were identified by the students in response to this question.

Structured group interviews

Of the 19 students in the program, 7 participated in one of the debriefing sessions (4 in the first session and 3 in the second). The feedback from the students across both sessions suggested an overall positive and valuable experience with the three-session, one-on-one program. Table 4 summarizes the responses and themes for each of the eight questions asked during the debriefing sessions. Themes identified in structured interviews aligned with responses from weekly survey evaluations.

[Insert Table 4 about here]

Table 4
Responses to Structured Interview Questions

Question	Key Findings and Student Feedback	Themes
1. Previous Experience with AI?	Most students had limited prior experience. Used ChatGPT primarily for personal, non-academic use (e.g., random questions, detailed explanations, finding recipes, travel plans).	Limited prior experience; Non-academic use.
2. Program Helpful? Format? Recommendations?	The program was found to be useful in learning Scopus AI and EBM application. The one-on-one format was highly valued for being intimate, brief, easy to digest, interactive, and allowing for immediate answers.	Program effectiveness; Format preference (intimate/interactive); Recommendation (start training sooner).
3. Experience with Scopus AI Features?	Liked: References (linked, verifiable, peer-reviewed), "Go Deeper," "Concept Map," Expanded Summary, bullet-pointed/numbered display format, ability to synthesize a proper care plan. Suggested improvement: Desired features like conversational search history (to modify/continue a thread) and a mobile app for clinical accessibility.	Trust in sources; Feature utility; Accessibility improvements.
4. PICO Format Helpful?	Generally found very useful and helpful. It aided in creating more specific prompts for clearer, better-synthesized care plans. Was considered easier to remember and more applicable for quick, clinical searches. One student noted a risk of "narrowing results too much" if too specific.	Clinical applicability; Ease of use/memory; Specificity vs. result volume.
5. CLEAR Format Helpful?	Considered less useful than PICO for the clinical task. Students felt "lost," or found it harder to remember and implement properly. Suggested it may be more pertinent for a general review (such as board preparation) or research rather than quick, evidence-based patient care.	Less clinical focus; Complexity/learning curve; Better for research.
6. Difference from Previous AI?	Scopus AI provides better specificity for medical problems, offers a proper care plan, and, most importantly, provides verifiable, peer-reviewed references—a key differentiator from tools like ChatGPT.	Professional utility; Credibility/verification.
7. How to use this approach in Patient Care?	Students plan to use it in the clinical setting to: refresh their memory quickly, provide a framework for EBM questions, and tailor and simplify research data into tangible, understandable, and reinforced information to share with patients.	EBM application; Patient education; Quick clinical checks.

Question	Key Findings and Student Feedback	Themes
8. Additional Comments	Reiterated the need for a mobile app or easily accessible device in the clinic. Raised questions about access after graduation (alumni portals, residency library access, and Elsevier's future business model). Students also appreciated the program's flexibility and accommodating scheduling.	Future access; Program flexibility; Technology integration.

Five key themes were identified during these sessions. First, students appreciated the application to clinical care. Most students had limited prior experience with AI, primarily using platforms like ChatGPT for non-academic and leisure purposes. The training successfully demonstrated a valuable, new professional application of AI for patient care and evidence-based medicine. Second, they identified strengths of Scopus AI. Compared to other generative AI platforms such as ChatGPT, Scopus AI was specifically valued due to its ability to provide credible, verifiable, peer-reviewed references, its medical specificity, and its presentation of summarized articles. The "Go Deeper" and "Concept Map" features were highlighted as being particularly helpful for synthesizing a care plan or generating new prompt ideas. Third, students valued the one-on-one format. The one-on-one format was highly praised for being intimate, brief, easy to digest, and highly interactive. One suggestion for improvement was to start the training earlier in their medical education. Fourth, PICO was preferred over CLEAR for clinical use. The PICO framework was considered more straightforward, easier to remember, and more directly applicable for quick, focused searches in a clinical/EBM setting. The CLEAR format was viewed as more flexible but less immediately useful, possibly better suited for general review or research. Fifth, students recommended increasing accessibility of the tool. A significant point of discussion and recommendation was the need for a mobile application to make it easily accessible for quick use in the clinic or at the patient's bedside as a point-of-care resource. Students also expressed concern about losing access to the tool upon graduation.

Discussion

Students enjoyed the one-on-one interactive online instructional format. This is consistent with findings from previous studies which also demonstrated students' preference for interactive lectures and demonstrations[25] and one-on-one instruction.[26] Traditional one-on-one instruction, while highly effective, is often not feasible for large cohorts due to the need for substantial faculty time and individualized attention.[27] Therefore, one-on-one instruction is greatly valued but must be scaled appropriately, balancing value and cost.

Students found the closed, AI-enabled research database, Scopus AI, to be a valuable tool for locating information relevant to clinical care. They specifically noted its ease of use and applicability, even suggesting the development of a mobile application for enhanced point-of-care access during patient care activities. Students reported high confidence in their ability to generate prompts. E-learning

technologies and AI tools, like Scopus AI, are generally perceived to optimize study time, provide up-to-date information, and improve understanding of medical concepts.[28] The resource is a licensed, AI-assisted database that exclusively uses peer-reviewed and vetted references from Elsevier, making it a closed system. Students appreciated the quality and reliability of the output generated through prompt engineering.

Asking and framing a clinical question is considered the first step when applying the principles of evidence-based practice.[3,4] Through demonstrations of prompt engineering, students in this program were effectively introduced to the first step of EBM in an authentic manner: developing the clinical question. Effective EBM courses can significantly improve students' understanding and application of EBM principles.[29] Two of the most effective curricular methods for teaching EBM (courses/workshops and clinical practice collaboration)[4] were used in this instructional program.

Both the PICO and CLEAR prompt engineering frameworks are commonly used and well-regarded, serving distinct purposes in various contexts.[5,13,14] While this study was not designed for a head-to-head comparison, PICO was preferred over CLEAR when generating prompts and applying evidence-based medicine to clinical scenarios. Students considered the PICO framework as being more straightforward, easier to memorize, and more directly applicable for the rapid, focused searches required in a clinical setting. Students appreciated the CLEAR format for its flexibility and potential utility in broader research or general reviews. Ultimately, the structured nature of PICO served as a valuable tool for enhancing workflow efficiency, as it helped students streamline the identification of relevant data and reduce the need to manually sift through numerous research articles.

Despite promising findings, this study had a number of limitations. First, the study was conducted at three healthcare centers from one university. Expanding to other sites would improve the generalizability of findings. Second, we did not study the quality of the EBM searches or how the students applied the evidence in a clinical setting. It would be interesting to see how and when students use the evidence when talking to patients. Third, only Scopus AI was used to conduct the EBM search. Relevant articles from other databases (government websites and resources from other publishers, for instance) may have been overlooked. Fourth, a formal prompt engineering text analysis was not performed. Investigating the sophisticated relationships between prompt text input and output would be of future interest.

Conclusions

This study demonstrates that a brief, individualized one-on-one instructional program can successfully equip fourth-year medical students with the prompt engineering skills necessary to navigate evidence-based medicine in an AI-driven landscape. By leveraging a closed AI system, students were able to mitigate the risks of hallucinations, providing high confidence in their ability to retrieve verifiable, peer-reviewed clinical evidence. Medical curricula should continue to prioritize the integration of authentic,

clinically-oriented educational programs to ensure trainees can master prompt engineering skills throughout their medical training.

Abbreviations

ADHD: Attention Deficit Hyperactivity Disorder

AI: Artificial Intelligence

EBM: Evidence-Based Medicine

LLMs: Large Language Models

NLP: Natural Language Processing

PICO: Patient, Intervention, Comparison, Outcome

CLEAR: Concise, Logical, Explicit, Adaptive, Reflective

Declarations

Ethics approval and consent to participate

Students completed the three 45-minute training sessions as part of their requirement for the rotation. As part of the post-rotation evaluation, all were invited to voluntarily participate in the final group discussion for which verbal informed consent to participate was given. A $50 gift card was offered to those who successfully completed the entire program and the large group discussion. At the conclusion of the rotation, this study (program evaluation) was reviewed and approved as a secondary analysis, exempt from informed consent by the Philadelphia College of Osteopathic Medicine (PCOM) Institutional Review Board (Protocol #H25-028X). The study was conducted in accordance with the Declaration of Helsinki.

Consent for Publication

Not Applicable

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

Grant support was provided by the Liberty Chapter of the Medical Library Association.

Author's contributions

EL and HLC developed the curriculum, administered the educational program, devised the methodology for program evaluation, and collected and analyzed data. HLC secured funding. EL wrote the initial draft of this manuscript. EL and HLC revised and approved the final manuscript.

Acknowledgements

Not Applicable

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- SupplementB.WeeklyAssessment.docx
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