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Students' perceptions of instructor-authored AI tutors used as optional, guided-inquiry supports in an Engineering Statics course

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Introduction

Courses in engineering disciplines require students to engage in complex, multi-step problem solving that builds sequentially on foundational concepts. In these contexts, timely feedback and individualized guidance can play an important role in supporting student learning [1, 2]. However, such support is often constrained by instructor availability, scheduling, and the scalability of traditional tutoring resources [1].

AI tutors have been increasingly explored in STEM education as a means of providing on-demand guidance and feedback [3]. Prior research and systematic reviews report generally positive student perceptions of AI-supported tutoring tools, particularly with respect to clarity of explanations, perceived accuracy, and ease of use, especially in structured and sequential domains such as mathematics, physics, and programming [1]. At the same time, the literature emphasizes that AI tutors are most effective when used as supplemental supports rather than replacements for human instruction, and that usability and pedagogical alignment are critical factors influencing student experience [2].

In this study, we examine the implementation of a set of instructor-authored, GPT-based AI tutors designed to support guided-inquiry and conceptual problem solving in an undergraduate Engineering Statics course. The AI tutors were deployed as optional, out-of-class learning supports and were designed with explicit instructional constraints intended to encourage student reasoning rather than solution copying. The focus of this paper is on students’ perceptions of these AI tutors, including usability, instructional quality, comparative helpfulness, and learning engagement, as measured through repeated surveys and open-ended feedback.

Methods

This study was conducted in an undergraduate Engineering Statics course delivered synchronously in a remote format using live video conferencing during the Fall 2025 semester. The course enrolled second-year engineering students. Use of the AI tutors was optional and not required for course credit. For analysis, only students who completed more than half of the post-session surveys were included. This criterion resulted in a final analytic sample of seven students, each of whom submitted responses to at least four surveys during the study period.

A suite of seven AI tutors was developed using OpenAI’s Custom GPT framework within ChatGPT to provide tailored student support. Each AI tutor was designed to guide students through the solution of one representative statics problem aligned with a specific topic from the second half of the course. One AI tutor was deployed per week, covering the following topics in sequence: (1) static equilibrium of rigid bodies, (2) truss analysis, (3) analysis of frames and machines, (4) internal loading, (5) friction, (6) centroids, and (7) area moments of inertia. Each AI tutor was provided with an instructor solution as a private supporting reference.

The AI tutors were designed with a consistent instructional philosophy and interaction protocol to promote guided inquiry, student agency, and conceptual understanding while preventing solution-focused use.

- **Guided-Inquiry Focus:** AI tutors were instructed to support student reasoning and problem-solving rather than provide direct solutions.
- Solution-Withholding Constraint: AI tutors were instructed to avoid providing final answers or fully worked solutions, offering conceptual or directional guidance only as needed.
- **Structured Stepwise Framework:** AI tutors were instructed to guide students through problems one step at a time, requiring completion and confirmation before advancing.
- **Student-Directed Interaction:** AI tutors were instructed to allow students to control the pacing and direction of the interaction by identifying the next step.
- **Consistent Instructional Tone:** AI tutors were instructed to maintain a calm, professional, and encouraging teaching-assistant–like demeanor, emphasizing clarity and precision.

Students were given the problem statement for each AI tutor before interacting individually with the AI tutors outside of class as a supplemental learning resource. After interacting with each AI tutor, students were asked to complete a post-session survey assessing their experience. The survey consisted of nine Likert-scale items rated on a five-point scale from 1 (strongly disagree) to 5 (strongly agree), followed by one open-ended question soliciting qualitative feedback, asking students to suggest improvements for the AI tutors. The Likert-scale items measured four broad constructs with the following questions:

1 Usability and Accessibility:
   a) Comfort with AI: I feel comfortable using AI tools to support my learning.
   b) Ease of Use: The AI tutor was easy to access and use.

2 Instructional Quality:
   c) Response Clarity: The AI tutor's responses were clear and easy to understand.
   d) Perceived Accuracy: The AI tutor provided accurate and correct information.

3 Comparative Value:
   e) Comparative Helpfulness: The AI tutor was more helpful than the publisher's tutorials.
   f) AI vs. Human Tutor Preference: I prefer using the AI tutor over asking a human tutor for quick questions.

4 Learning Impact and Efficiency:
   g) Increase in Confidence: Using the AI tutor increased my confidence in this subject.
   h) Time Efficiency: The AI tutor saved me time compared to other study methods.
   i) Learning Engagement: Using the AI tutor made me feel more engaged in learning the material.

Results

Table 1 summarizes the descriptive statistics and 95% confidence intervals for student responses to the post-session Likert-scale survey. To account for the repeated measures design, aggregate descriptive statistics in Table 1 were calculated by first averaging responses at the student level

($N=7$). Overall means, standard deviations, and 95% confidence intervals were then derived from these student-level averages using a t-distribution with 6 degrees of freedom.
Mean ratings for most items were above the scale’s neutral midpoint. The highest overall mean ratings were observed for Ease of Use, Comfort with AI, Response Clarity, and Perceived Accuracy. Moderate mean ratings were observed for Comparative Helpfulness relative to publisher-provided tutorials, Learning Engagement, Time Efficiency, and Increase in Confidence. Lower mean ratings were reported for AI vs. Human Tutor Preference.

Table 1 – Descriptive statistics for Likert-scale survey responses across all survey administrations, 42 total responses from 7 students. (1 = strongly disagree and 5 = strongly agree)

Survey Item	Mean	Standard Deviation	95% Confidence Interval
a) Comfort with AI	3.79	0.84	(3.01, 4.57)
b) Ease of Use	3.81	0.71	(3.15, 4.47)
c) Response Clarity	3.77	0.67	(3.15, 4.39)
d) Perceived Accuracy	3.77	0.53	(3.28, 4.26)
e) Comparative Helpfulness	3.65	0.70	(3.00, 4.30)
f) AI vs. Human Tutor Preference	2.75	0.67	(2.13, 3.37)
g) Increase in Confidence	3.38	0.56	(2.86, 3.90)
h) Time Efficiency	3.42	0.67	(2.80, 4.05)
i) Learning Engagement	3.58	0.62	(3.01, 4.15)

To examine whether student perceptions of the AI tutors changed over the course of the semester, trends in mean Likert-scale survey responses were analyzed across the seven survey administrations. Figure 1 presents trends in mean Likert-scale survey responses across the seven survey administrations for each survey item. Across all items, responses exhibited modest week-to-week variation, with no clear monotonic increases or decreases observed over the duration of the study.

Items related to Comfort with AI, Ease of Use, Response Clarity, and Perceived Accuracy remained consistently above the neutral midpoint across survey administrations. Items associated with an increase in Confidence, Time Efficiency, and Learning Engagement showed moderate variation but no sustained directional trend. Ratings for AI vs. Human Tutor Preference remained lower than other items throughout the study period and did not exhibit systematic change over time. Overall, student perceptions of the AI tutors remained relatively stable across the implementation period, with confidence intervals generally decreasing for later AI tutorials, indicating reduced variability in responses over successive weeks.

When asked to suggest improvements to the AI tutors, most respondents said they had no specific suggestions or concerns. A small number of responses provided additional qualitative feedback, from which the following themes emerged:

- **Technical and Platform Limitations:** Some students reported technical issues unrelated to instructional design, including slow response times, interface freezing, and account usage limits that interrupted interaction with the AI tutors.
- **Usability and Interface Simplicity:** A small number of comments suggested that the interface could be made more user-friendly and simpler to navigate, indicating potential improvements in ease of interaction rather than instructional content.

- **Desire for Broader Coverage:** One respondent suggested expanding the AI tutors to support additional types of statics problems, indicating interest in broader applicability of the tool.
- **Comparison with Human Tutoring:** One comment emphasized that human tutors offer real-time responsiveness and visual awareness of student work, highlighting perceived advantages of in-person interaction.
- **Perceived Effectiveness of Instructional Constraints:** One response explicitly praised the tutors for not providing answers immediately and for encouraging independent problem-solving, aligning with the intended guided-inquiry design.

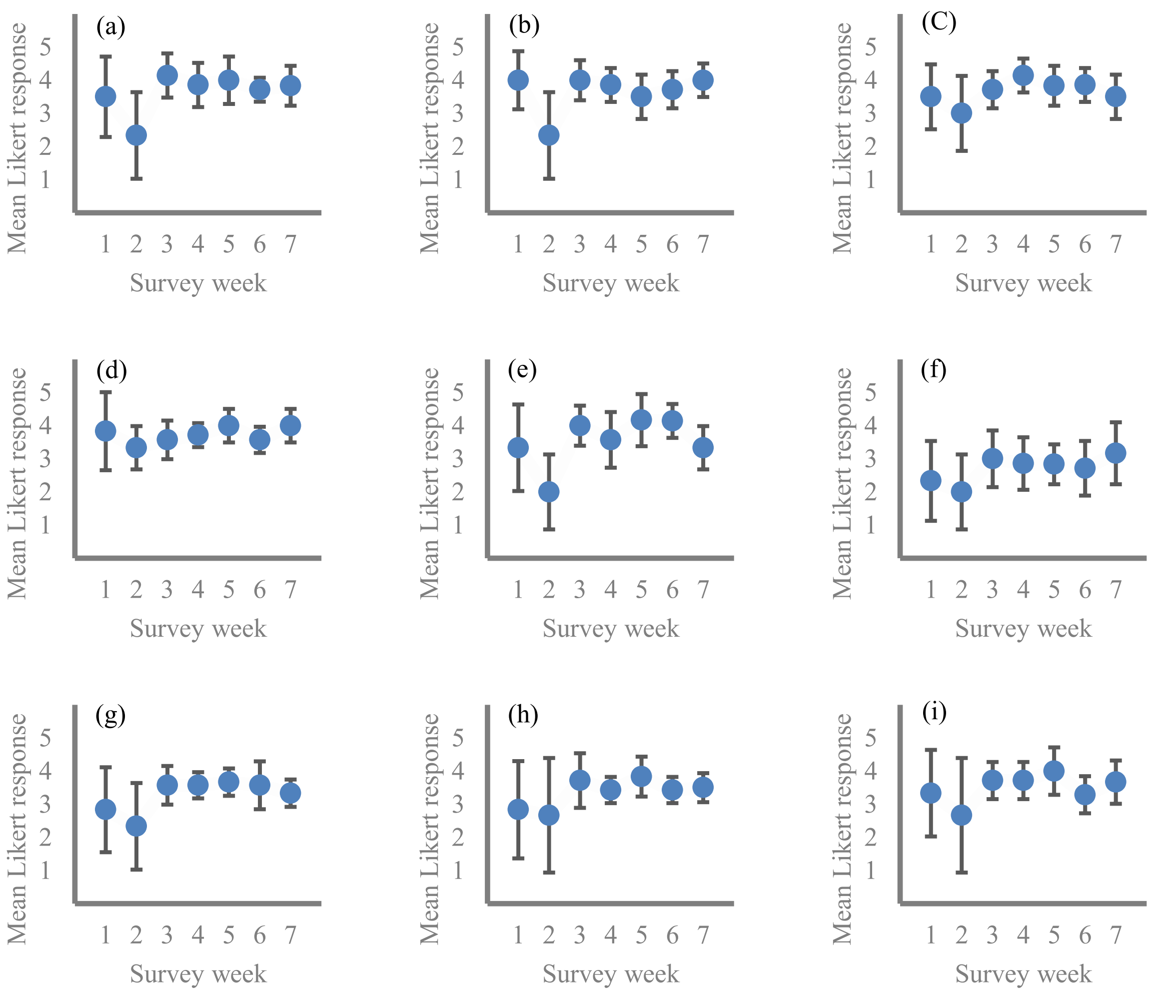

Figure 1 - Trends in mean Likert-scale survey responses across seven survey administrations. Panels (a)–(i) correspond to the survey items listed in Table 1: (a) Comfort with AI, (b) Ease of Use, (c) Response Clarity, (d) Perceived Accuracy, (e) Comparative Helpfulness, (f) AI vs. Human Tutor Preference, (g) Increase in Confidence, (h) Time Efficiency, and (i) Learning Engagement. Error bars represent pointwise 95% confidence intervals for each administration. Likert-scale responses range from 1 (strongly disagree) to 5 (strongly agree).

Discussion

This study examined student perceptions of a suite of instructor-authored AI tutors designed to support guided-inquiry and conceptual problem solving in an undergraduate Engineering Statics course. Overall, survey results indicate that students in this course viewed the AI tutors as accessible, clear, and accurate instructional supports. High ratings for Comfort with AI, Ease of Use, Response Clarity, and Perceived Accuracy are consistent with prior studies reporting positive student perceptions of AI tutors in structured STEM domains, where clarity and usability are central factors influencing acceptance and sustained use [1, 2].

Moderate ratings for Increase in Confidence, Time Efficiency, Learning Engagement, and Comparative Helpfulness suggest that the AI tutors were perceived by students in this course as beneficial but not transformative. This pattern aligns with prior literature emphasizing that AI tutors are most effective when used as supplemental supports rather than replacements for instruction or practice [2]. The relatively lower ratings for AI vs. Human Tutor Preference further reinforce this interpretation, indicating that students continue to value human tutors for certain types of support, particularly those involving real-time responsiveness, contextual awareness, or interpersonal interaction [2]. Broader reviews of AI in STEM education similarly argue that AI tools should be viewed as components within a larger instructional system, rather than substitutes for human instructors [3].

Analysis of trends over time showed that perceptions of students in this course remained stable across the implementation period, with confidence intervals generally decreasing for later tutorials, indicating reduced variability in responses. This stability suggests that student experiences with the AI tutors did not diminish as novelty effects waned and may reflect the consistent instructional philosophy and interaction protocol applied across all tutors.

Open-ended responses provided limited qualitative feedback, with most students reporting no specific suggestions for improvement. The few comments that were offered primarily referenced technical or platform-related issues, interface simplicity, and interest in broader problem coverage, rather than concerns with the instructional approach itself. Notably, the presence of both positive and critical comments regarding Solution-Withholding Constraint reflects variability in student expectations about how directive an AI tutor should be. Similar variability has been documented in prior studies, underscoring the importance of clearly communicating the intended role and instructional constraints of AI tutors to students.

Several limitations should be considered when interpreting these findings. The study involved a small sample size drawn from a single course, and participation in the AI tutor activities was optional, which may introduce self-selection bias. The results reflect perceptions of students in this course rather than direct measures of their learning outcomes, and conclusions about instructional effectiveness should therefore be interpreted cautiously.

Transcripts of student–AI interactions were also collected to provide insight into student reasoning processes, engagement patterns, and common misconceptions, and to examine how effectively the AI tutors adhered to their intended instructional design. The results of this analysis are not reported in this manuscript and will be included in future work. Future work will also expand the sample size, incorporate direct measures of learning, and more closely examine tutor–student interactions to better understand how AI tutor behavior aligns with intended instructional constraints.

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