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The Required Use of AI on Engineering Economics Homework: A Study in Student Perception Changes over the course of A Semester

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Abstract: The use of generative AI in the understanding engineering economics classroom was required over the course of a semester for students to validate their homework problems. This was integrated into a third of the homework required for the course, and students reflected on how AI answered the homework questions compared to their own solution. A pretest and posttest consisting of nine Likert-Scale questions and two open-ended questions administered on the first and last day of class showcased change in student attitudes regarding their confidence of using AI and their ability to integrate generative AI into their learning process. This is supported by both a moderate effect size (*Θ = 0.60)* and statistically significant change (p = 0.02) on the confidence question and a moderate effect size (*Θ = 0.52)* and statistical significance (p = 0.04) on the integration question. Thematic analysis of the qualitative questions illustrates initial student hesitation about AI ethics and concern about how AI will replace their learning process. Posttest data show the growth over the semester: students identify generative AI drawbacks, especially in it answering questions incorrectly. Their confidence in how and where to use AI increases for their own learning. This growth highlights the importance of teaching undergraduate students how to use AI as a professional tool and offers a framework of asking students to verify their own solutions to do so.

1. Introduction

The evolution of AI started as a pet project for an academic and has evolved into a ubiquitous term and tool many people use daily. The term artificial intelligence was coined by John McCarthy in 1955, where he proposed that 10 researchers at Dartmouth spend their summer exploring how every aspect of learning or intelligence could be simulated by machines [1]. Later defined more specifically by renowned AI researcher Nilsson, AI is a machine displaying intelligent behavior. These encompass genetic programming, heuristic search, knowledge representation and reasoning, planning, and language processing [2].

AI's link to educational support can be traced through numerous disciplines. Medical schools have been using AI since 2000, with the main application in learning (simulation and intelligent tutoring) and less frequently supporting assessment and curriculum development [3]. In 2014 a meta-analysis was conducted on the efficacy of intelligent tutoring systems versus traditional tutoring in medicine, law, and reading finding the intelligent tutoring systems "relatively effective tools for learning [4]," showing that AI could perform as well as in-person tutors. After the advent of generative AI, more detailed research has been conducted, especially in engineering. In three chemical engineering courses, researchers found that upper-level students used AI for more sophisticated tasks like research and technical writing, while lower-level students used it for homework assistance and concept clarification [5].

The integration of AI initially was in support of other tools. On a technological level, applications of AI were used to support robot exploration in places like Antarctica and Mars. More accessible to the public, in early 2000 Microsoft introduced Clippy into Word platforms, aiming to make tasks more frictionless. Certainly, it was not until generative AI was released on a large scale November 2022 that AI became a common term in households. Now that AI is ubiquitous, it has even larger implications for educators. It will become an important professional tool, and as educators we should both learn how to use it and how to teach with it. This paper aims to explore how student's AI perceptions change over the course of a semester by requiring them to use it as a learning tool to check homework solutions. The research questions are:

1. How do student perceptions of generative AI change from the beginning to end of a semester when they are required to use AI to verify their homework (measured by quantitative pre/post questions)?
2. Do students identify strengths and weaknesses of AI after using it for a semester on engineering economics homework (as measured by qualitative pre/post questions)?

The following sections outline how the study was implemented into an engineering economics course. Qualitative and quantitative results will be shown, with a discussion on the statistical and thematic results from the pre/post questionnaire.

2. Methods

This study uses a mixed-methods approach, combining qualitative and quantitative data from a survey to capture how student perceptions of generative AI use on homework changed during the course of the Fall 2025 semester. The pretest was administered on day one of the course, the posttest on the last day of the course before the final exam. A total of eighteen students consented to the study (Campbell University IRB No. 977) and completed both the pre and posttest.

2.1 Integrating AI Into Homework

At the university where the survey was conducted, professors have agreed upon a problem heuristic taught in first-year courses. It is threaded through the curriculum and aims to give novice students a structure for solving engineering problems. Called engineering format, this heuristic is extensively taught in both first and second semester first-year engineering courses, consisting of 25% of the test grade for each test. Because students come in as novice problem solvers, the idea is to provide a structure and process whereby students can mimic the thinking of an expert. Table 1 describes the eight steps in engineering format.

Table 1: Description of problem heuristic used in undergraduate engineering courses.

Step	Description
Given	Summarize the given information from the problem statement that is relevant to what you are trying to find. If you wish to re-write the problem statement, that is allowed but should occur before the Given and be separate from it.
Find	This is a specific statement of what you are trying to find by solving the problem (including units if the assignment specifies them).
Representation	Include a graphical depiction or diagram (qualitative model) that will aid you in describing and solving the problem. A representation should be neat with straight lines, round circles, and clear labels. If multiple different aspects or angles of the problem are described by the problem statement, more than one drawing may be needed to completely represent the problem. If Given or Find values have been named, they should be referenced in the illustration of the problem.
Assumptions	List any and all additional assumptions made to solve the problem. Facts, theorems, or information given in the problem statement should not appear as Assumptions – only new assumptions that you have made. For many questions, no assumptions will be needed beyond those given in the problem statement and recorded in the Given section. In this instance, writing "No additional assumptions" is sufficient.
Model	For each Model section, the specific item to be modeled or solved for should be clearly indicated at the beginning of the section in writing. Identify the constitutive equations, graphs, figures, or correlations which can quantitatively represent the system. Justify in writing the selection of the equations or other tools. Solve the problem or sub-problem symbolically. For some problem types, it may not be possible to symbolically solve the entire problem before solving for one or more intermediate values. In these cases, multiple model and solution steps should be employed to find the final answer. No numeric values should be used in the models. Units should not be employed or assumed here.
Solution	Input the Given values, any values looked up, and/or values calculated in a previous Solution step into the completed Model, compute the values of interest, and evaluate units. If your model is correct and you employ unit conversion as necessary, this step will often be 'plug and chug'. For problems where multiple models need to be used to find the final answer each model should have its own distinct solution followed by the next model needed to solve the problem paired with a solution until the problem is completely solved. Place major solved-for values in boxes for easy identification.
Verification	The goal of this section is to employ some means to verify your math, ensuring that you plugged numbers into your model correctly. You are verifying that your answer is mathematically correct based on your model. Verifying your mathematical manipulations, computations, and unit conversions can be accomplished by substituting solution values into the

	model's original equations to solve for one or more of the given values and units – if they match, your mathematics and unit conversions are likely correct. Problems with multiple models and solutions within only require verification for answers listed in the Find section.
Validation	The goal of this section is to determine if your model leads to sensible conclusions (correct order of magnitude, sign, etc.). Validating that the model itself is sound can be done using estimation methods to generate simpler models, by confirming that the answer falls between known-sensible bounds, or by determining the answer via an independent solution procedure. Validation requires developing some level of quantifiable evidence that the model is appropriate and outputs sensible solutions. Problems with multiple models and solutions within it only require validation for answers listed in the Find section. Verification and Validation are not the same thing, so combining them into one section is not acceptable.

In the engineering economics class, there are 16 total homework assignments given in a semester. Five of these are all on excel and five have no problems that are assigned in engineering format. Of the six left, an average of two problems on each of these assignments are required in engineering format. For the study, students were required to use generative AI to complete the verification and validation portion of engineering format on each of these problems. Correct numerical answers were provided to these problems so students could verify if their solution and/or the AI solution was correct. For each problem conducted with AI, students were asked to answer the following questions:

1. Using a generate AI platform of your choice, ask the AI to solve the problem for you.
2. As a follow up prompt, ask the AI to show you the steps to complete the problem.
3. Answer the following questions:
    a. Is the AI correct (yes/no)?
    b. Is the solution the AI provided sufficient information to follow the answer?
    c. Comment on the solution and consider the following questions:
        i. Did you learn something new from the AI?
        ii. Did the AI solve the problem in the way you expected?
        iii. Did the AI make assumptions you think unreasonable or have incorrect information?

Answering these questions was required as part of the student's homework grade. Students were not required to use a specific platform for generative AI and data collection did not include the platform students used. All students were required to complete this portion of the homework, whether they consented to the study.

2.2 Survey

To evaluate student perceptions of AI, a survey was conducted both on the first and last day of class. The survey consisted of nine Likert-Scale questions and two open-ended questions aimed at capturing student confidence and changing perceptions of AI. The open-ended questions intentionally ask students to reflect on their experiences over the course of the semester, especially considering how AI might change the way they learn in the future. The instrument was replicated from Bilgin et al.'s paper investigating student perceptions of AI in chemical engineering courses [5]. The questions were written to investigate five key areas of student interaction with AI. These include confidence and integration (questions 1-2), critical thinking and evaluation (3-4), problem-solving and performance (5-6), trust and scientific validity (7-8), and awareness of limitations (9). Table 2 illustrates the both the Likert-Scale questions and the Open-ended questions.

Table 2: Survey Questions

Likert-Scale Questions
Q1. I am confident in my ability to use AI tools for academic purposes.
Q2. I feel comfortable integrating AI tools into my learning process.
Q3. I understand how to critically evaluate the output of AI tools.
Q4. AI tools can help improve my understanding of engineering.
Q5. AI tools make it easier to solve complex problems in engineering courses.
Q6. I believe AI can enhance my academic performance.
Q7. I trust the outputs generated by AI tools to be accurate and reliable.
Q8. I believe AI tools provide explanations that are scientifically sound.
Q9. I am aware of the limitations of AI tools in engineering applications.
Open-Ended Questions
Q1. What are your initial (final) thoughts in the beginning (end) of the semester about using AI tools for learning engineering concepts? (How have they changed to the end of the semester?)
Q2. What are your concerns, if any, about relying on AI for academic purposes?

2.3 Data Analysis

Data analysis consisted of both qualitative and quantitative analysis of the survey results. The quantitative Likert-Scale Questions were analyzed using Microsoft Excel. Descriptive statistics and a paired two-tail t-test was performed on the pre/posttest data using Excel functionality. A p-value of 0.05 is considered significant. The effect size, or Cohen's D which represents the difference between the pretest (first day) and posttest (last day) group mean scores divided by the pooled standard deviation, offers additional insight into the degree of effectiveness of the AI homework intervention. Cohen first discussed the importance of effect sizes in behavioral sciences [6] and later these were specified to educational studies by Valentine and Cooper. They defined an effect size of 0.8 as large and greater than 0.5 as moderate. An effect size of 0.8 translates to eight tenths of a standard deviation difference between the mean of the two groups [7].

The two open-ended questions were analyzed using thematic analysis, a qualitative research methodology. Qualitative research aims to offer answers to the questions "why?" and "how?" leaning on constructivist theories that posit people's past social, historical, and individual experiences affect the way they view and engage with the world [8]. The particular method employed in this qualitative thematic analysis is triangulation, which can be performed by one researcher and aims to compare findings from different methods (thematic analysis and quantitative analysis) to offer more insights into study results [8]. The individual thematic analysis involved three distinct steps with one happening simultaneously. First, the author compiled the qualitative data and read and re-read responses to each question. After compiling disassembling occurred, whereby the author created meaningful groupings of like responses and coded these groupings based on themes, concepts, or ideas. The last step is reassembly where themes emerge, and patterns are recognized in the codes. While each of these steps is occurring, the researcher is also interpreting the qualitative data – drawing conclusions from the codes and themes and answering research questions [9]. This process was used separately on each of the pretest and posttest questions. Results are shared in the next section.

3. Results

3.1 Quantitative Results

An analysis of the mean scores on pre/posttest perceptions in AI questions are illustrated in the comparative bar chart in Figure 1 and statistic summary in Table 3. These provide evidence that the AI homework intervention had a significant effect altering student confidence in AI *(Q1, p = 0.02, Θ = 0.60)* and their ability to integrate AI into their learning *(Q1, p = 0.04, Θ = 0.52)*.

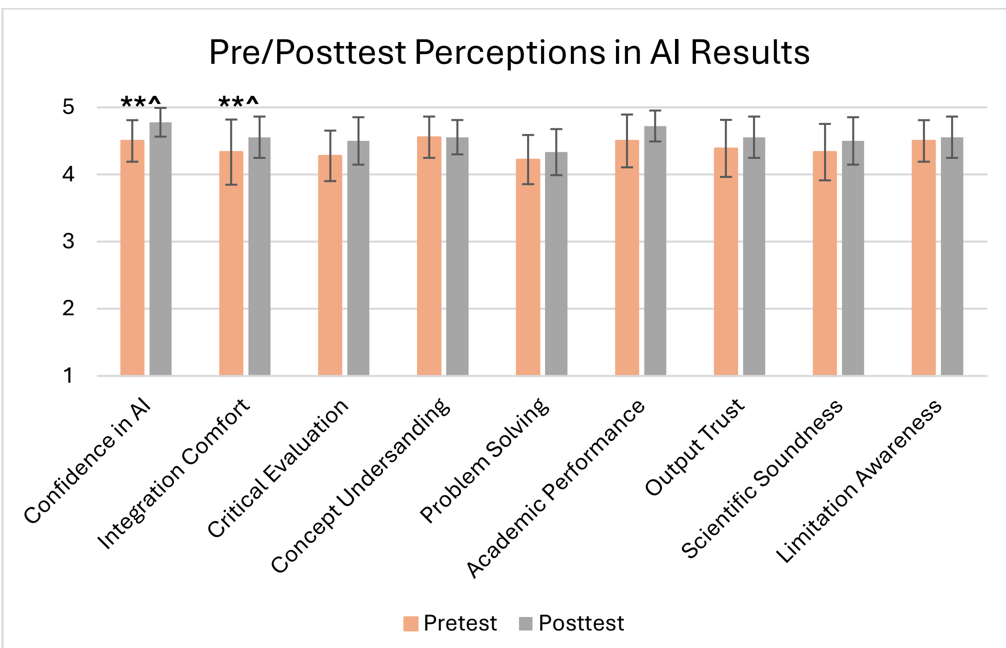

*Figure 1: Comparison of pre- and posttest mean and standard deviation for the Perceptions in AI instrument. (** = p<0.05, ^^ = high effect size, Θ>0.8, ^ = moderate effect size, Θ>0.5)*

The quantitative data illustrates a few patterns that can assist engineering educators in how they understand student perceptions of AI. First, it was notable that none of the pretest means were below a Likert-Scale of 4 (agree). This finding in itself illustrates that undergraduate students both know and have perceptions of generative AI. The intervention whereby students were required to use AI to verify their work and use it as a learning tool rather than a learning replacement (which many schools and educators fear) showcased how both student confidence and their ability to integrate AI into learning significantly changed over the course of a semester. These initial patterns can be combined with the qualitative data to offer a richer insight into how this intervention specifically altered students perceptions of AI.

Table 3: Statistical summary including p-values and effect sizes for each of the nine quantitative questions.

Question	Question topic	P-value	Effect size, Θ
1	Confidence in AI	0.02	0.60
2	Integration Comfort	0.04	0.52
3	Critical Evaluation	0.10	0.41
4	Concept Understanding	1	0
5	Problem Solving	0.33	0.23
6	Academic Performance	0.10	0.41
7	Output Trust	0.08	0.43
8	Scientific Soundness	0.08	0.43
9	AI help Engineering Understanding	0.33	0.24

3.2 Qualitative Results

The qualitative thematic analysis performed on the two-open ended questions provide further evidence that student perceptions changed from cautious to more confident regarding their ability to integrate AI into their homework. The main thematic highlights from the pretest questions are:

1. Students are unsure of the ethics of AI

AI is still a relatively new technology, and even though it is becoming more ubiquitous many students do not have a framework for how to use or think about AI. One stated "*I have taken a seminar on how to use AI to further learning instead [of] replacing it, but it kind of feels wrong."* One who uses it said "*AI can be wrong and is wrong a lot*" and another said, "[AI] *can give different answers to the same question that contradict with one another*."

2. Concern that AI will remove / replace the learning process

This theme arose in different ways between responses, but many students feared that AI would prevent themselves and others from deep learning. One student said "*When tested, you do not know the material because AI did most of the work."* Another was much more forthcoming, stating "*[AI] may take away from creating formative learning experiences."*

These two themes also highlight another important phenomenon: at the time the pretest was administered (first day, Fall 2025) all students who responded had either experience using generative AI or opinions about how AI could intersect with their engineering education. Furthermore, it showcases that students share concerns regarding learning (and their future career) and ethical issues surrounding AI.

The posttest qualitative results illustrate student growth over the course of the semester. Key themes from the posttest include:

1. AI is often wrong and cannot be relied upon for solving all engineering problems

Many students identified times when AI told them the wrong answer. One said "*Sometimes it will correct itself whenever I tell it what it did wrong, but other times it tries to gaslight me.*" This sentiment was shared by several students, with a few citing fears that AI would circulate misinformation and would lead to people believing the AI answer when it is false. Another said, "*After finishing this course, I can see that the AI is not ready yet to solve the most complex problems this class had. In many cases … AI was not able to correctly solve the question.*" A few students were more descriptive, indicating where AI fell short in helping the learning process. One stated, "*Now I see that AI doesn't always do a great job at expanding on the questions and tends to skip steps or consolidate steps that I usually find helpful in solving problems. I don't tend to learn as well when steps are consolidated which makes it harder to learn anything new from the AI tools.*"

2. With consistent use, students have identified how to use AI for their learning

Several students said they had found where generative AI could now help them the most in their learning. One said "*AI has allowed me to get immediate feedback on problems to correct my ways of thinking.*" Another said, "*I had been taught it was a form of cheating, but…I have come to appreciate it as a problem checker.*" A third student said, "*I was terrified that I would grow dependent and not learn … I am still concerned [but] have found it helpful in teaching connections and concepts or asking it to reword for clarity.*"

The thematic analysis supports the same trend as the quantitative results: students changed in their confidence of using AI and how to integrate it into their learning process. The qualitative data show where students were initially less confident using AI: they didn't trust it was ethical to use academically. The growth over the semester is clear with the posttest results. Students accepted that AI could be used as an ethical educational tool to enhance rather than replace learning. They even identified ways beyond the initial framework of how to use it as a tutor and clarification tool. The qualitative and quantitative data taken together can lend insight into answering the two research questions explained in the discussion.

3.3 Discussion

The qualitative and quantitative evidence provided showcased student growth in both confidence of using AI and in integration of AI into their learning process. The two statistically significant Likert-Scale questions paired with the arc of the thematic analysis offers insight into the first research question, investigating how student perceptions of generative AI change over a semester. The two statistically significant Likert-Scale questions and combined moderate effect sizes highlight that over the course of the semester, student perceptions regarding confidence of using AI for academics and employing AI effectively in their learning process positively changed. The thematic analysis shows how they changed. Initially students were hesitant and unsure of how to employ AI to help them with their studies. However, after being given a framework and several opportunities to engage with AI, students identified specific ways that AI could help them with their learning, answering the second research question.

The second research question probing if students discovered strengths and weaknesses of AI is supported by the qualitative data. The posttest qualitative data showed that with repeated use, students utilized the initial framework (use AI to check your homework) and found other uses that were helpful in learning. Several sighted it as a tool to explain concepts or clarify confusing engineering questions. Students said AI has clear strengths and many said they would continue to use it after this study. It was also very clear that students recognized AI has weaknesses. Many said it was helpful the correct numerical solutions were provided so they knew when AI was giving them wrong information. The hallucinations (AI giving incorrect responses) from generative AI are well known shortcomings of the tool. The more interesting discovery from the qualitative data is that AI will argue that it is correct when it is not. Recognizing a tool's shortcomings is an important step in knowing how to use a tool to improve task performance.

From an educational perspective, students' ability to learn where and how to use AI to advance their learning and where it may hinder is a success. This ability is supported by Viet's analysis and published principles for use of generative AI in higher education: that it should be used as a "tool to support critical thinking development" [10]. By demonstrating and requiring the use of AI in homework, students were able to shift their perceptions about generative AI and learn how to use it to enhance and supplement, not replace their learning. Furthermore, students recognized some of the challenges and risks of generative AI, also highlighted by Viet et al. They identified issues surrounding "academic integrity … and the risk of over-reliance on technology, which could undermine critical thinking and independent learning" [10].

The implication of this study shows that given appropriate frameworks, students can alter their perceptions of AI over the course of a semester. It highlights the need for figures of authority in higher education to demonstrate how to use this tool effectively and give students opportunities to test it themselves. Students typically only engage with content if grades are linked to it, so the methodology whereby students were graded on whether they used generative AI as a validation tool likely contributes to the change in student attitudes over the course of the semester. Additionally, by highlighting how generative AI is another tool in an engineer's toolbox, student hesitancy subsided over the course of the semester, replaced by confidence and a deeper understanding of the tool itself.

3.4 Limitations

It should be acknowledged that this study was performed on a single engineering economics course at a small, liberal-arts university in the southeast USA in the Fall of 2025. Eighteen students consented and because it was in Fall 2025 and generative AI is evolving so rapidly, student attitudes within a short time (1-3 years) may rapidly progress. The study could certainly be complemented with more data, and the effect size was calculated to better contextualize the results of the small sample.

This study only looked at student perception changes over time when they interacted with AI. It offers no insight into whether changing students' perceptions of AI over a semester improves their learning. Further studies would need to be performed to see if AI helps learning and where it would best help learning in the undergraduate engineering classroom.

4. Conclusion

Over the course of the semester, undergraduate students in engineering economics at a small liberal arts university were required to use AI as a verification tool on their homework. Eighteen students consented to complete a pretest administered on the first day of class and posttest administered on the last day of class. The test consisted of nine Likert-scale questions and two open-ended questions. Students employed a problem heuristic called engineering format to verify their problems. This step-by-step process, taught throughout the curriculum at this school, gives students a model to mimic solving engineering problems like an expert. The second to last step is verification, whereby the solver needs to re-run math to confirm the calculated answer. On two problems for a third of the homework in the course, students were asked to complete this step using AI.

The study employed a mixed-methods approach with the quantitative results determined by a two-tailed paired t-test and qualitative results analyzed using thematic analysis. Results show that two of the nine questions had statistical significance and moderate effect sizes. Students have identified that the intervention changed their confidence in using AI for academic purposes with a moderate effect size ($\Theta = 0.60$) and statistically significant change ($p = 0.02$). Additionally, students identified changing their comfort integrating AI into their learning process with a moderate effect size ($\Theta = 0.52$) and statistical significance ($p = 0.04$). The qualitative results showcase growth over the semester: initially students were unsure about how to use AI ethically in their academics and where to integrate it in their learning. With the intervention showing them how to use the AI on their homework, qualitative posttest thematic analysis illustrates a significant shift in students' attitudes. They are more aware of AI's limitations and how and where to use it as a tool in their academics. Students also recognize that AI cannot replace the learning process. These results showcase that as educators we need to teach students how to effectively integrate AI into learning. This method of asking them to verify their homework was one effective solution, showcasing perception change of student confidence in AI and how to integrate it into their academics over the course of a semester.

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