Student Perspectives on AI in Engineering Courses: Ethics, Learning, and Pedagogical Implications

Dr. Turhan K. Carroll, University of Georgia

Dr. Turhan K. Carroll is an Assistant Professor of Workforce Education at the University of Georgia. He specializes in engineering education and quantitative methodology. His research spans physics education, informal STEM learning, and K–12 engineering education, with a focus on student learning, equity and access. His current research explores how students use generative AI in undergraduate lab settings, the long-term impacts of informal STEM experiences, and strategies to support diverse and low-income K–12 learners in pursuing engineering pathways.

With 10+ years as a practicing engineer and over 15 years working with educators nationwide, Dr. Carroll has developed and evaluated hands-on STEM programs in classrooms, summer camps, and outreach initiatives. His work bridges research and practice to create transformative STEM learning experiences.

Dr. Carroll earned his PhD in Engineering Education with an interdisciplinary specialization in Quantitative Research Evaluation and Methodology from The Ohio State University. Prior to joining the College of Education, he was a postdoctoral researcher in the College of Education and Human Ecology at The Ohio State University. Prior to his graduate work he worked as an engineer at the Air Force Research Laboratory in Dayton, OH.

Anna Grace Peebles, The University of Georgia
Dr. John M Mativo, The University of Georgia

Dr. John Mativo is Associate Professor at the University of Georgia. His research interest lies in two fields. The first is research focusing on best and effective ways to teaching and learning in STEM K-16. He is currently researching on best practices i

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Abstract

The rapid rise of generative artificial intelligence (AI) tools marks a turning point for undergraduate engineering education, presenting extraordinary opportunities as well as complex pedagogical challenges. Students now have access to powerful technologies capable of performing sophisticated analyses, generating written explanations, solving complicated equations, and visualizing dynamic systems, all of which can potentially deepen conceptual understanding and support independent learning. At the same time, these tools raise important questions about academic integrity, classroom assessment validity, and the design of learning experiences that remain authentic and equitable. Understanding how students are currently using AI tools, and their perceptions about AI use in their coursework is essential for developing informed instructional strategies, clear ethical guidelines, and meaningful course policies.

This exploratory qualitative study presents findings from an open-ended survey conducted with undergraduate students enrolled in an engineering dynamics course at a large research university in the Southeastern United States. By inviting students to reflect on their experiences using (or choosing not to use) AI tools for assignments and problem-solving, as well as the perceived effects of these tools on their learning, confidence, and academic integrity. The study explored three research questions:

(RQ1) What do undergraduate engineering students in a dynamics class at a large research university in the Southern United States perceive as ethical, appropriate, and productive use of AI in their coursework?

(RQ2) How do these students describe their AI practices, skills, and decision-making processes, and how do these relate to their adoption of course AI use polices?

Our findings indicate that students possess sophisticated conceptual frameworks for ethical AI use centered on supporting learning processes rather than bypassing them. Students' responses also revealed a broad range of AI competencies, from non-users to daily practitioners, with prompting effectiveness identified as a critical skill gap. Across both research questions, a tension was identified between using AI for efficiency (quick answers, completing assignments) and using AI for learning (understanding concepts, developing problem-solving skills). By providing an initial empirically grounded understanding of how students currently engage with these tools, this work contributes to ongoing discussions about responsible AI use, the preservation of academic integrity, and the development of innovative pedagogical policies and models that leverage AI to augment, rather than undermine, student learning.

Introduction

The Accreditation Board for Engineering and Technology (ABET) ABET's mission is to promote and improve technical education worldwide [1]. The history of the accreditation body testifies of the mission. ABET is supportive of the use of generative artificial intelligence (AI) technology to enhance student learning experience but does not advocate for replacing fundamental knowledge, skills, and ethical practice. It continues to state that academic integrity has to be safeguarded, and it supports critical thinking and should not rely on automated answers.

Studies indicate that AI- assisted instruction improves academic achievement indirectly by promoting learning behaviors. This action fosters competence development which is critical to learning [2]. AI in engineering instruction is an added tool to pull various resources to the user, where the user has to sift through the resources to identify specifics that are needed to address the issue at hand.

The fundamentals of engineering have to be taught such that they are understood and correctly applied. It is incumbent on the instructor to determine what works in their fields. In no way should AI become the decision maker, or a replacement of a sound instructional process. Engineering education fundamentals require informed individual(s) to make decisions having an appropriate knowledge base and upholding ethical standards. As engineers, we are accountable for our designs, and outcomes of our implementations.

Therefore, AI should be viewed as a partner in instruction strategies to enhance learning without compromise in knowledge, skills, and engineering ethics, but should not replace human judgement.

There has been a rapid introduction of AI in the form of large language models such as ChatGPT, which has changed instruction, education, and assessment practices in higher education. Since the public was introduced to ChatGPT in late 2022, higher education institutions have struggled with questions surrounding students' use, ethical responsibility, and academic integrity [3], [4].

This study investigates two the following research questions:

(RQ1) What do undergraduate engineering students in a dynamics class at a large research university in the Southern United States perceive as ethical, appropriate, and productive use of AI in their coursework?

(RQ2) How do these students describe their AI practices, skills, and decision-making processes, and how do these relate to their adoption of course AI use polices?

Review of Literature

Productive Uses of AI and Student Adoption

Scholars have found. show that students use AI primarily for uses they perceive as learning enhancing and efficiency-related [3], [5], [6]. Biyiri et al. found that undergraduate students use AI to support self-directed learning activities like planning, monitoring, understanding, and reflecting on progress [5]. Supporting their analysis with the Unified Theory of Acceptance and Use of Technology (UTAUT), they found that students are most likely to use AI when they believe it genuinely helps them learn and work more effectively. Students tend to adopt AI not simply because it is available, but because they see clear value in how it supports their understanding and helps them reflect on their learning process [3], [5]. Black and Tomlinson found that students use AI for revising drafts, explaining confusing concepts, generating example problems, and checking their understanding of concepts [3]. These purposes for using AI are perceived as appropriate because AI is not being used to replace original thinking [3], [6]. Existing studies suggest that students are more cautious about using AI to find final solutions, and more trusting of AI to help with explanation, verification, or practice uses they perceive as productive and aligned with learning goals [6].

Ethical Perceptions of AI among Higher Education Students

Students' ethical views of AI are shaped by context and by what they are trying to accomplish. Students simply do not label AI ethical or unethical; they tend to judge whether it is appropriate based on their intentions, how it affects the learning, and the course policies [7]. Across different areas of study, students are comfortable justifying AI use for purposes that support education, like receiving feedback or checking errors, rather than for uses like avoiding mental work required for the assignment [4].

Research does reveal gaps in students' ethical awareness [7]. Yang et al. (2025) find that students prioritize cheating and dependency while paying less attention to access, bias, and equity among other students [7]. Rismanchian et al. found that many undergraduate students overestimate AI's reasoning capabilities, which leads to questionable reliance on AI [8]. This misconception is alarming, especially for more technical disciplines, because this unrestricted acceptance can lead to incorrect outputs and totally undermine learning. Usher & Barack study suggests that students' ethical reasoning about the adoption of AI is flexible [9]. The study shows that intense ethics instruction improves students' ability to evaluate AI use scenarios. They concluded that instruction helps shift ethical reasoning from following policy toward personal judgment. The literature suggests that students' perception of appropriate AI use is not shaped only by policy but also by AI literature [7], [8], [9].

Student Practices, Skills, and AI Literacy

Recent studies have shown the importance of understanding what students do when they are using AI and how students do it [3], [5]. These studies report a range of uses from asking for hints, generating practice problems, checking work, diving into explanations, and working through reasoning. These differences in how students use AI at varying levels of AI literacy range from basic prompting to more strategic engagement [3], [5].

Students' level of AI skills plays a significant role in how students interact with GAI tools. Oc et al. found that factors such as risk, trust, and capability with technology influence how confidently students use AI [10]. Students with higher perceived technology skills tend to tailor AI to their benefit, like tailored prompts, check multiple AI responses, and choose when to even rely on AI. In contrast, less experienced students often express uncertainty about what appropriate use is and are more likely to depend on AI outputs. Singer-Freeman et al. clarified these patterns as well, along with finding that first-year undergraduate students are more cautious, and the upper-level undergraduate students demonstrated less caution when using AI [11]. This pattern suggests that AI is developmental and grows and changes as the students become more familiar with AI.

Students' Decision Making and Policy Interpretation

With the introduction of AI in 2022, higher education has been working to create a guide for students on ethical use, and studies are showing that students are not simply adopting policies but are interpreting these policies and applying them differently [11], [12]. Jiang et al. report that students are more aware of course policies than institution-wide policies [12]. Students tend to find institutional policies vague or often unrelated to their coursework. The study did find that the more restrictive the policies are, the greater the reduction in the use of AI. Singer-Freeman et al. found that students desire clear guidelines, especially early in their academic careers [11]. Singer- Freeman et al. found that students rely on their instructors' opinion on AI when it decides to use AI in their academic work, and these expectations draw into students ethical reasoning when deciding how to use AI. When an instructor expresses a position of negativity or positive towards the use of AI in their students' learning, this shapes the students' understanding on the appropriate use of AI.

Synthesis and Research Gap

The literature that is available paints a picture of how widely adopted AI is among higher education students. Students use AI to help with supporting learning, productivity, and it was shown not to be used in place of brain power. Literature also suggests that students' appropriate use of AI is shaped by their personal skill level, developmental stage, and class context. AI is shown to not only rely on technical skills, but also on students' ability to use judgment on how and when to use it. The literature showed that instructors coming out and letting students know how they feel about AI tools ultimately influences the students the most. Class policies and institution policies do not keep students from using AI or help in developing their AI skills.

The literature covers a wide range of contexts, fewer studies address AI use within engineering courses. By examining students' perspectives in an engineering dynamics class this study helps address this gap. It investigates how engineering students at a research institution in the southern United States understand ethical, appropriate, and productive uses of AI in their coursework. Additionally, the study also addresses how engineering students describe their AI practices, skills, and decision-making processes.

Methods

Context and Participants

This study was conducted at a large research university in the Southeastern United States during the Fall 2025 semester. Participants were undergraduate students enrolled in an engineering dynamics course, a required core course typically taken in the sophomore or junior year in this institution's engineering curriculum. The course covers kinematics and kinetics of particles and rigid bodies in linear, circular and general motion.

Of the 36 students enrolled in the course, 32 completed the survey, yielding a response rate of approximately 89%. The high response rate suggests the findings are reasonably representative of the class. All students were invited to participate regardless of their prior experience with or attitudes toward AI tools.

Questionnaire Design

Data was collected using a questionnaire consisting of six questions designed to explore student self-reported perceptions, practices, and competencies related to AI use in engineering coursework. Five questions were open-ended to allow students to share their experiences and perspectives in their own words, while one question used a yes/no format to assess self-reported understanding of the course's AI-use policies. The questions were developed to align with the study's two research questions. The questions are listed below in Table 1. RQ1, which explored perceptions of ethical, appropriate, and productive AI use, was Primarily addressed through Question 5 and Question 3. RQ2, which regards AI competencies, practices, and policy interpretation, was addressed through Question 1, Question 2, Question 3, and Question 6. Question 4, which asked about other digital tools students use, provided contextual information to situate AI use within students' broader technology practices.

Table 1: Questions used in the student questionnaire.

Question 1	Describe your familiarity and comfort level with generative AI tools such as ChatGPT/Claude/Gemini.
Question 2	What are some things you would like to learn about use of AI tools for solving problems in your engineering courses?
Question 3	Detail some of the ways in which students use ChatGPT/Claude/Gemini and similar tools to complete exercises in engineering courses.
Question 4	Detail whether there are additional digital tools that students use to help with exercises in their engineering courses? If so, specify the software name and its uses.
Question 5	List some possible ethical ways that AI tools can be used to help students solve problems in engineering courses.
Question 6	Do you feel that you usually have a good understanding of the AI usage policy in your engineering courses? Circle One: Yes / No

Data Collection

Anonymous questionnaires were administered to the students in the middle of the semester. They were administered via paper questionnaire forms which were distributed at the conclusion of a single class period. Participation was voluntary and were part of an optional part of an extra credit activity given in class. Students were informed that their responses would be kept confidential and used for research purposes to improve teaching practices. The students who chose to participate filled out the questionnaire and turned them in to the course instructor. The completed forms were then given to the other members of the research team, and transcribed verbatim for coding.

Data Analysis

All members of the research team participated in the data analysis process except the course instructor. The team members who engaged in the analysis process will be referred to as the analysts.

The qualitative data from the five open-ended questions were analyzed using thematic analysis [13]. We employed an inductive, semantic approach [14] to develop themes grounded in the explicit meanings present in student responses. The analysts engaged in the following process outlined by Braun and Clarke [13]:

- *Familiarizing with the data*: The analysts read through all responses multiple times to gain overall familiarity with the data and begin identifying initial patterns.

- *Generating initial codes*: The analysts systematically worked through each response, generating initial codes that captured specific concepts, practices, or perspectives expressed by students. Codes were developed inductively from the data rather than from predetermined categories.
    - Example: In Question 5 (ethical uses), the analysts identified codes such as "step-by-step guidance," "concept explanation," "practice problem generation," "checking work," and "formula reference." Each response was coded for all relevant concepts it contained, allowing for multiple codes for each response.
- *Constructing themes*: The codes were examined to identify patterns and relationships that suggested broader themes. Related codes were collated into potential themes based on the analysts' interpretation of conceptual connections across student responses.
    - Example: Codes around "step-by-step guidance," "concept explanation," and "not giving complete answers" were interpreted as reflecting a broader pattern about process-oriented versus product-oriented AI use. The analysts constructed initial themes and worked to organize them in relation to the two research questions.
- *Reviewing themes*: Candidate themes were reviewed against the coded data and the entire dataset to ensure themes were coherent, distinct, and accurately represented the data. Some initial themes were refined, combined, or separated based on the analysts' ongoing interpretation.
    - Example: We initially constructed separate themes for "tutoring metaphor" and "appropriate help-seeking," but these were combined into the second theme within RQ1 because we interpreted both as reflecting the same underlying concept of AI as supplemental support.

- *Defining and naming themes*: The specifics of each theme were refined to determine exactly which aspect of the data each theme captured and what made it distinct from other themes. We developed clear definitions and scope for each theme and selected names that conveyed our interpretation of the theme's essence.
    - Example: The first theme within RQ1 was named "The Pedagogical Boundary: Process Over Product" to capture our interpretation of students' distinction between learning-focused and answer-focused AI use. We identified representative quotes that illustrated the main ideas of each theme.
- *Producing the report*: We organized themes by research question and selected quotes to illustrate each theme. The analysis was structured to tell a coherent story about student perceptions and practices while maintaining analytic rigor. Themes were presented with sufficient evidence and contextualized within the research questions.

The yes/no response data from Question 6 were analyzed descriptively to determine the proportion of students who reported understanding course AI-use policies. Throughout this process, because the research questions were addressed across multiple survey items, we synthesized findings from different questions to develop comprehensive themes. For example, understanding student AI competencies (RQ2) required integrating data from Questions 1, 2, 3, and 6. Investigator triangulation was used to enhance trustworthiness, with multiple researchers reviewing the data.

Findings

The analysis of student survey responses revealed distinct patterns in how these undergraduate engineering students perceive and engage with AI tools. Results are organized by research question, with themes supported by representative student quotes. Overall, 32 students provided responses, with 29 (91%) indicating they understand course AI-use policies. However, the qualitative data reveal considerable complexity in how students conceptualize appropriate AI use and varying levels of competency with these tools.

RQ1: Perceived Ethical, Appropriate, and Productive Uses of Generative AI

Four major themes were constructed through our analysis that illustrate what students perceive as ethical, appropriate, and productive uses of generative AI in their engineering coursework: The Pedagogical Boundary: Process Over Product; AI as Tutor, Not Substitute; Productive Use Hinges on Tool Reliability; and Utility for Study and Organization.

The Pedagogical Boundary: Process Over Product

Students consistently distinguish between ethical use, which focuses on understanding processes and concepts, and problematic use, which centers on simply obtaining final answers. When asked about ethical AI applications (Question 5), 15 students emphasized step-by-step guidance that stops short of complete solutions, and 17 students highlighted concept explanation and clarification. Students articulated a clear value: AI should support learning, not replace it.

One student explained: “AI could be used to assist. For example, one might see a problem and not know how to approach it. AI can provide step by step instructions without solving it completely. It can also help students with additional explanation of concepts or as to why you do certain actions.” Another emphasized the importance of withholding final answers: “Ask not to use numbers or final answer but give partial steps to begin solving problem.” A third student captured the distinction succinctly: “explaining how to get the answer...Instead of just giving it where students can skip to the end.”

However, when describing actual AI use patterns (Question 3), students revealed tension between these ideals and practice. Seventeen students (53%) described complete problem-solving as a common practice, “throw whole assignments into AI and just copy down answers”, even as many of these same students articulated process-oriented ethics. One student acknowledged this gap directly: “Some students just copy questions, but it is better to go step by step with the GenAI. This leads to better more accurate results.”

This finding suggests that while students possess a clear conceptual framework for ethical AI use centered on learning processes, the practices they report suggest inconsistent adherence to these principles.

AI as Tutor, Not Substitute

Students frequently employed a tutoring metaphor to describe appropriate AI use, framing ethical engagement as analogous to asking a professor or teaching assistant for help. One student stated directly: “Ask it questions or for tips you would typically ask a professor.” Another described AI as “really valuable tool to learn as it can explain concepts to you without simply solving it for you.”

This tutoring framework appeared across multiple questions. When describing their comfort with AI tools (Question 1), students noted using them as “study aids and tutors” and seeking help to “act as a tutor.” Four students in Question 5 specifically mentioned checking work after attempting problems themselves, mirroring responsible help-seeking behavior with human tutors.

The tutor metaphor establishes clear boundaries: just as having a tutor complete your homework would be unethical, having AI solve problems entirely crosses an ethical line. However, asking AI for explanations, hints, or clarification (activities students would appropriately do with a human tutor) appears to remain within students’ ethical bounds.

Productive Use Hinges on Tool Reliability

Students' perceptions of productive AI use were heavily qualified by concerns about accuracy and reliability, particularly for complex engineering problems. When asked what they wanted to learn about AI tools (Question 2), accuracy and reliability emerged as the top concern, mentioned by 10 students. As one explained: “I often see AI giving me incorrect answers/working problems wrong. How can I improve its accuracy, so I am not misled.”

Students recognized that AI performs differently across problem types. One noted: “AI can do some of the simpler problems pretty easily but it can get messed up with more complex problems.” Another was more blunt: “highly inaccurate pertaining to Dynamics and other similar courses I'd like to learn how to increase accuracy.” Several students described AI as “inconsistent when solving more complex equations” and expressed frustration that “A lot of times AI messes up on harder problems and won't know how to solve it.”

These reliability concerns shaped students' willingness to use AI. One student reported: “lots of engineering problems can't be solved by AI yet so I don't typically use it for homework.” This awareness suggests that productive use, in students’ minds, is not merely about ethical boundaries but about practical effectiveness: AI can only productively support learning when it provides accurate information.

Utility for Study and Organization

In contrast to the qualified views about problem-solving assistance, students expressed strong consensus that using AI to organize information, generate study materials, and summarize course content represents clearly ethical and productive use. Seven students mentioned practice problem generation: “create practice questions” and “creating sample problems on topics students are learning for practice.” Six students highlighted organizational uses: “break down/condense slides...create cheat sheets/formula sheets” and “Upload slides and ask to summarize all concepts etc. for studying.”

Five students specifically mentioned formula and equation reference as appropriate, and six described AI as a study and review tool, with one explicitly noting it should be used “ethically for review/studying, but not for test/homework.” These applications were perceived as unambiguously appropriate because they support preparation and active studying without replacing student thinking during graded assessments.

Summary of RQ1 Findings

Students articulated sophisticated conceptual frameworks for ethical AI use centered on supporting learning processes rather than bypassing them. The tutor metaphor and process-over-product principle provide clear ethical guidance. However, reliability concerns complicate productive use in technical domains like dynamics, and reported practices reveal gaps between ethical ideals and actual behavior. Study preparation and organizational tasks emerge as unambiguously appropriate uses.

RQ2: AI Competencies, Practices, and Policy Interpretation

Six themes were identified through our analysis regarding students' AI competencies, decision-making processes, and understanding of course policies: Wide Range of Competency and Adoption; Prompting as Critical Competency Gap; Critical Awareness of AI Limitations; Limited Tool Diversity: ChatGPT Monoculture; Varied Practice Patterns Reveal Different Use Philosophies; and High Self-Reported Policy Understanding but Questions Remain.

Wide Range of Competency and Adoption

Students demonstrated highly variable levels of AI familiarity, comfort, and usage patterns. Analysis of self-reported familiarity (Question 1) revealed:

- Frequency: 7 students (22%) reported daily use, 12 (38%) regular use, 7 (22%) occasional use, 5 (16%) rare use, and 1 (3%) had never used AI tools.
- Comfort: 13 students (41%) described themselves as very comfortable, 13 (41%) moderately comfortable, 5 (16%) had low comfort, and 1 (3%) had never used these tools.

Representative quotes illustrate this spectrum. At the high end: “use tools several times a day for a variety of tasks” and “extremely comfortable...use them almost everyday as study aids and tutors.” In the middle: “use it occasionally for assignments...decent with using it.” At the lower end: “use them for certain classes but have only recently started doing so. I feel somewhat guilty about using it” and “Not very comfortable, haven't used them too often.”

This wide variation suggests the class contains students with radically different AI competency levels, from complete non-users to sophisticated daily practitioners. This heterogeneity has important implications for policy development and pedagogical approaches.

Prompting as Critical Competency Gap

Students identified effective prompting (e.g. knowing how to formulate questions to elicit useful, accurate responses) as a major skill gap. Nine students in Question 2 specifically mentioned wanting to learn about prompting effectiveness. One explained their current limitation: “used ChatGPT a fair bit but still have trouble getting it to do what I want.” Another noted: “the most difficult part is giving a proper prompt to them, and by making it clear and simple as possible.”

Students wanted to learn how to “use it more effectively...good prompts to help it act as a tutor” and “better prompt answers so that I can get more accurate solutions...train AI models to more accurately solve dynamics problems." One student wanted to know "What I could ask, show, tell to the AI engine that would help it give me the process/answer in a more step-by-step format."

Evidence from Question 3 suggests that students recognize prompting approach affects output quality. One noted: "Some students just copy questions, but it is better to go step by step with the GenAI. This leads to better more accurate results." This awareness indicates students view prompting not just as a technical skill but as central to effective and ethical AI use.

Critical Awareness of AI Limitations

Many students demonstrated metacognitive awareness that AI is not always reliable, particularly for complex engineering problems. This skepticism represents an important form of competency: knowing when not to trust AI outputs. Ten students in Question 2 expressed concerns about accuracy and reliability, and five students in Question 3 specifically noted AI limitations when describing current practices.

Students reported: "AI is inconsistent when solving more complex equations," "A lot of times AI messes up on harder problems, and won't know how to solve it," and "lots of engineering problems can't be solved by AI yet so I don't typically use it for homework." Some described strategies for managing unreliability: one student explained checking AI work by comparing "all the intermediate values" to identify "where my mistake is."

This critical awareness shapes decision-making about AI use. Students who recognize accuracy issues will be equipped to make more informed choices about when to rely on AI, what types of problems to bring to AI, and how to verify AI-generated solutions.

Limited Tool Diversity: ChatGPT Monoculture

Despite varying comfort levels, nearly all AI users relied exclusively on ChatGPT, with minimal awareness or use of alternative tools. Thirty-one of 32 students (97%) mentioned ChatGPT when describing their AI tool familiarity, while only 4 (13%) mentioned Gemini and zero reported using Claude. Several students explicitly noted limited tool awareness: "The only AI tool I know is ChatGPT," "only used ChatGPT twice and have not heard of Claude or Gemini," and "ChatGPT-Moderately, Claude-completely unfamiliar, Gemini-slightly familiar."

When asked about other digital tools (Question 4), 11 students mentioned Chegg, and smaller numbers mentioned Desmos (n=4), MATLAB (n=2), Wolfram Alpha (n=1), and various calculators and specialized software. However, 12 students (38%) indicated they didn't know of additional digital tools or could not think of any.

These responses suggest a competency gap in tool selection. Students may lack awareness that different AI tools have different strengths, or that specialized computational tools (like Wolfram Alpha for mathematical computations) might better serve certain tasks. The ChatGPT monoculture may reflect both brand recognition and lack of exposure to alternatives.

Varied Practice Patterns Reveal Different Use Philosophies

Students described diverse strategies for engaging with AI, revealing different underlying philosophies about appropriate use. Analysis of Question 3 responses showed:

- Complete problem-solving: 17 students (53%) described giving AI entire problems to solve
- Step-by-step guidance: 16 students (50%) described working through problems incrementally with AI
- Concept explanation: 13 students (41%) described asking AI to explain concepts or terms
- Formula/starting help: 8 students (25%) described using AI for equations and starting points
- Study aid: 10 students (31%) described using AI to prepare for coursework
- Error checking: 4 students (13%) described using AI to verify their work

Many students described employing multiple strategies, and several articulated clear philosophies distinguishing different approaches. One stated: “Students can use AI to solve problems for them all they would need are certain inputs. Students should use it to assist them and not just solve it for them.” Another efficiency-focused student reported: “Use it to solve problems and just get straight to the correct answer especially if homework is online.”

These varied patterns suggest students are developing personal frameworks for AI use, but these frameworks differ considerably and may not always align with instructor expectations or course policies. The prevalence of complete problem-solving (53%) alongside high rates of step-by-step approaches (50%) indicates students employ different strategies in different contexts or for different purposes.

High Self-Reported Policy Understanding but Questions Remain

Twenty-nine students (91%) reported understanding course AI-use policies (Question 6). However, qualitative responses revealed ongoing questions about appropriate use, suggesting potential gaps between perceived and actual understanding or between policy clarity and real-world application.

Despite high reported policy understanding, students in Question 2 still expressed uncertainty about ethical boundaries. One asked: “would like to learn...if it is ethical to use them for academics (how does using them in compliance with academic honesty look?).” Another wanted to know: “what the general consensus is when it comes to how professors view the use of AI. I assume most of them disagree with the use but I would really like to know why exactly.”

One student in Question 1 noted that they “Feel somewhat guilty about using it,” suggesting internalized uncertainty about appropriateness despite reported policy understanding. This guilt, combined with continued questions about ethics and appropriate use, suggests that self-reported policy understanding may reflect superficial familiarity (“I read the policy”) rather than deep understanding of how to apply policies to specific situations.

The disconnect between high reported understanding and persistent ethical questions may indicate that policies exist and are communicated but remain abstract or ambiguous when students face real decisions about using AI for specific assignments or problem types.

Summary of RQ2 Findings

Students demonstrate a wide spectrum of AI competencies, from non-users to daily practitioners, with prompting effectiveness identified as a critical skill gap. Most students show awareness of AI limitations and make decisions informed by reliability concerns. However, AI use is dominated by ChatGPT with limited tool diversity. Practice patterns vary considerably, reflecting different underlying philosophies about appropriate use. While 91% report understanding course policies, qualitative responses suggest ongoing uncertainty about boundaries of appropriate use, indicating a gap between policy awareness and confident application.

The Efficiency-Learning Tension

Across both research questions, a fundamental tension was identified between using AI for efficiency (quick answers, completing assignments) and using AI for learning (understanding concepts, developing problem-solving skills). We interpret this tension as shaping both what students perceive as ethical (RQ1) and how they make decisions about use in practice (RQ2). Students articulate learning-centered ideals but face practical pressures that can pull them toward efficiency-centered practices. Navigating this tension appears to be central to students’ ongoing sense-making about responsible AI use in engineering education.

Discussion

This study examined undergraduate engineering students’ perceptions of ethical, appropriate, and productive uses of AI, as well as their self-reported competencies and understanding of course policies in an undergraduate dynamics course at a large research university in the Southeastern United States. Our findings reveal a student population actively engaged in sense-making about AI’s role in their education, articulating sophisticated ethical frameworks while simultaneously navigating practical tensions between efficiency and learning.

These results provide empirical grounding for engineering faculty and administrators seeking to develop informed instructional strategies, clear ethical guidelines, and meaningful course policies that leverage AI to augment, rather than undermine, student learning.

The Process-Product Paradox and Academic Integrity

Our most striking finding is the gap between students' articulated ethics toward AI use and their reported practices. Students clearly distinguished between process-oriented use (understanding concepts, learning problem-solving approaches) and product-oriented use (obtaining final answers), with strong consensus that the former is ethical while the latter is not. This aligns with research on academic integrity in digital contexts, which suggests that students often possess moral frameworks for ethical behavior but struggle to apply them consistently in practice [15].

However, over half of students (53%) described complete problem-solving as a common practice, even as many articulated process-oriented ideals. This paradox has important implications for course policy development. Simply articulating that students should use AI to "learn, not cheat" may be insufficient if students already hold this principle but struggle to apply it consistently. The boundary between step-by-step guidance and complete problem-solving may be more ambiguous in practice than in principle.

This suggests that effective AI policies must move beyond principle-level statements to include concrete, contextual examples [16]. Rather than stating only that "AI should support learning," policies might specify that students may use AI to explain concepts or check work after independent attempts, but not to solve homework problems step-by-step while transcribing answers. Additionally, policies should include decision-making frameworks students can use when uncertain, such as asking themselves whether they could reproduce the solution process independently.

The Competency Spectrum and Digital Literacy

We found that students demonstrate highly variable AI competency levels, from complete non-users (3%) to daily practitioners (22%), which has important implications for designing equitable learning experiences. This heterogeneity suggests that engineering educators must consider differentiated approaches that meet students where they are, consistent with principles of universal design for learning [17].

Two critical competency gaps were identified through our analysis. First, nine students identified effective prompting as a major skill need. As AI tools become more prevalent in engineering practice, prompt engineering may emerge as a fundamental literacy alongside traditional academic skills [18]. We believe that this is an area where engineering educators can emphasize the importance of human knowledge in the use of AI. Even though education on prompting may be important, this can also miss the point a bit. Engineering problems are complex and require a nuanced understanding of how various sets of constraints, assumptions, physical principles fit together. If students are encountering this material for the first time, they may not be proficient at breaking complex problems into smaller tasks, properly specifying problems, or adding appropriate constraints and parameters to ensure that solutions produced by AI apply specifically to the problem on which they are working. If learners use ideas for product-oriented uses, this could lead to overreliance on AI for problem specification, understanding of relevant assumptions, problem interpretation, and solution. In educational contexts, prompting expertise should focus on strategies that deepen understanding rather than maximize efficiency in extracting answers, such as requesting explanations without solutions or having AI generate practice problems.

Second, the ChatGPT monoculture (97% reliance on a single tool) reveals a significant gap in tool selection competency. Engineering education should explicitly introduce students to diverse computational resources and teach the metacognitive skill of selecting appropriate tools for different tasks, a form of digital literacy increasingly essential for professional practice [19].

Reliability Concerns as Pedagogical Opportunity

Students' widespread concerns about AI accuracy, particularly for complex engineering problems, may serve a protective function, preventing overreliance on AI for technical coursework. However, as AI capabilities improve, this natural barrier may erode. The critical evaluation skills students are currently developing out of necessity represent valuable competencies that should be formalized through explicit instruction [20].

Rather than viewing AI unreliability as a problem, engineering educators should consider designing assignments where students use AI to solve problems, then identify and correct errors in AI-generated solutions. This transforms reliability limitations into pedagogical features while developing verification and error-detection competencies valuable regardless of future AI accuracy levels [21].

The Policy Understanding Paradox

Our finding that 91% of our participants reported understanding course AI policies while simultaneously expressing ongoing uncertainty about appropriate use presents an important challenge for policy development. Students may interpret "understanding" as simply being aware that a policy exists, even if they find its application to specific situations unclear. Further study would be needed to clarify this distinction. The gap between principle-level awareness and confident application suggests that effective AI policies require concrete operationalization with specific scenarios illustrating acceptable and unacceptable uses [22].

Additionally, the feeling of guilt expressed by one student despite using AI suggests that some students can experience moral uncertainty even when following policies. Future work should consider the intersection of moral uncertainty and cognitive understanding, perhaps through classroom discussions that normalize uncertainty and provide opportunities for students to discuss ambiguous cases with instructors and peers.

Implications for Practice and Policy

Based on the findings from this study, we suggest several concrete strategies for engineering faculty and administrators seeking to develop effective AI policies and instructional approaches.

Developing Concrete, Contextual AI Policies

Given the gap between students' process-oriented ethical frameworks and their reported practices, we recommend that engineering programs move beyond principle-based policies to include specific, contextual guidance. Effective policies should:

1. Provide explicit examples of acceptable and unacceptable uses within specific course contexts. For instance, in a dynamics course, this might include: "Acceptable: Ask AI to explain the difference between static and kinetic friction; Use AI to generate three practice problems on rotational motion; Check your homework solutions against AI after completing independently. Unacceptable: Input homework problems and transcribe AI solutions; Use AI to work through exam problems step-by-step."

2. Include decision-making heuristics that students can apply when uncertain. For example: "Before using AI, ask yourself: (1) Could I explain this concept or solution process to a classmate without AI assistance? (2) Am I using AI to understand how to solve this type of problem, or to avoid learning the process? (3) Would I feel comfortable describing exactly how I used AI if asked by the instructor?"

Addressing the Prompting Competency Gap

To address the identified skill gap in effective prompting, we recommend that engineering courses:

1. Dedicate explicit instructional time to demonstrating educationally productive prompting strategies. This could include a brief lab or workshop where students practice prompting AI for conceptual explanations versus complete solutions, comparing outcomes and discussing which approaches support learning.

2. Model effective prompts during instruction. When explaining concepts, instructors might demonstrate: “If you were to ask AI about this concept, you might prompt: ‘Explain the relationship between force, mass, and acceleration without solving numerical problems’ rather than ‘Solve this dynamics problem for me.’”

3. Frame prompting as problem specification. Students need to understand that effective prompting requires deep domain knowledge to properly specify problems, identify relevant constraints and assumptions, and recognize when AI outputs are incomplete or incorrect. This reframes prompting as an advanced skill that builds on, rather than replaces, engineering knowledge.

Expanding Tool Literacy

To address the ChatGPT monoculture, engineering programs could:

1. Introduce students to diverse computational tools appropriate for engineering work, including specialized AI systems, symbolic computation software (Wolfram Alpha), numerical computation environments (MATLAB, Python), and domain-specific applications.

2. Teach tool selection as a metacognitive skill. Assignments might require students to solve the same problem using multiple tools and reflect on which was most appropriate and why, developing judgment about tool affordances and limitations.

3. Create a “tool selection guide” as a course resource that maps common engineering tasks to appropriate computational tools, helping students develop strategic thinking about technology use.

Leveraging Reliability Concerns Pedagogically

Rather than viewing AI unreliability as a barrier, we recommend that instructors:

1. Design verification assignments where students use AI to solve problems, then must identify errors, explain why the AI made mistakes, and provide corrected solutions. This develops critical evaluation skills while acknowledging current AI limitations.

2. Explicitly discuss AI limitations in class, helping students develop calibrated trust by understanding what types of problems AI handles well versus poorly in their specific domain.

Redesigning Assessments for the AI Era

To maintain assessment validity, engineering courses should consider:

1. Balanced assessment portfolios that include both AI-free assessments (in-class exams, proctored problem-solving) to measure individual competency and AI-supported work (projects, research assignments) that reflect authentic professional practice.

2. Process-focused assignments that require students to document their problem-solving approach, explain their reasoning, and justify their methods rather than simply providing final answers. AI can generate answers, but students must demonstrate understanding of the process.

3. Novel application tasks that require synthesizing concepts in ways that go beyond standard problems AI has likely encountered in training data. This might include designing solutions for novel scenarios, critiquing proposed engineering designs, or solving problems with unusual constraints.

4. Metacognitive components where students reflect on their AI use, explaining when and why they chose to use AI, how they verified outputs, and what they learned from the interaction.

Creating Opportunities for Ethics Discussions

Given the persistent uncertainty about appropriate use despite high reported policy understanding, instructors could:

1. Facilitate classroom discussions about ambiguous AI use cases, normalizing uncertainty and providing opportunities for peer dialogue about ethical boundaries.

2. Invite students to contribute to evolving course AI policies by sharing scenarios they've encountered and discussing as a class whether proposed uses align with learning goals.

3. Model ethical decision-making by discussing their own AI use (for course preparation, assignment design, etc.) and the reasoning behind their choices.

These recommendations are meant to represent actionable starting points based on our findings. As AI capabilities continue to evolve, ongoing assessment of student perceptions and practices will be essential for refining policies and pedagogical approaches.

Limitations

Several limitations should be noted. First, as a qualitative study, the analysis reflects the researcher's interpretation of the data. While efforts were made to ground interpretations in the data through iterative review, quote selection, and ongoing discussion, researcher biases will inevitably be reflected in our data interpretations to some extent. Second, the survey responses represent self-reported perceptions and practices, which may differ from students' actual behaviors or may be influenced by social desirability bias. Third, the study was conducted in a single course at one institution, limiting generalizability. Finally, the survey did not collect demographic information or academic performance data, precluding analysis of how AI use patterns might vary across student subgroups.

Conclusion

This study reveals undergraduate engineering students engaged in sophisticated sense-making about AI's role in their education, articulating clear ethical frameworks centered on supporting learning rather than bypassing it. However, the gaps between ideals and reported practices, between policy awareness and confident application, and between articulated competencies and skill needs all point to the complexity of integrating AI into engineering education in pedagogically sound ways.

The challenge for engineering educators is not to prevent student AI use but to channel that use toward deepening understanding, developing critical evaluation skills, and preparing students for professional contexts where human expertise and AI capabilities work in concert. By providing clear, concrete policies; explicit instruction in AI literacy; and thoughtfully designed assessments, engineering faculty can help students develop the judgment and competencies needed to use AI as a tool that augments rather than undermines their learning.

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