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Research Article

A STATISTICAL ANALYSIS OF ENGINEERING STUDENTS' USAGE AND PERCEPTIONS OF CHATGPT IN ENGINEERING EDUCATION

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Abstract

This study examines how engineering students use ChatGPT for academic work and how they evaluate its benefits, risks, and place within engineering education. The manuscript is based on a structured survey of 200 engineering students, predominantly from electrical, electronics, communications, and computer-related fields. The uploaded draft reports near-universal academic adoption, with 98.8% of respondents indicating ChatGPT use for academic purposes and 96.5% reporting more than six months of use. Descriptive results show that students most frequently use ChatGPT for understanding theoretical concepts, explaining formulas and algorithms, writing or debugging code, and preparing for exams. Perception measures indicate a strongly positive overall learning impact (M = 4.16/5), alongside high agreement for asking follow-up questions (M = 4.35), brainstorming support (M = 4.15), improved confidence (M = 4.14), and problem decomposition (M = 4.02). The perception scale demonstrated good internal consistency (Cronbach's $\alpha = 0.835$). The draft's inferential summary also reports a statistically significant positive impact relative to the neutral midpoint ($t = 9.6$, $p < 0.001$). Qualitative responses indicate that students value step-by-step explanations, conceptual simplification, coding assistance, and time savings, while continuing to express concerns about hallucinated information, shallow understanding, and dependency. Overall, the findings support guided not unrestricted integration of generative AI into engineering learning. The paper argues that engineering programs should pair AI access with verification practices, prompt literacy, and assessment designs that reward reasoning, transparency, and original problem solving.

Keywords: ChatGPT, Engineering education, Generative AI, higher education, Student perceptions, Academic integrity, AI literacy.

INTRODUCTION

Generative artificial intelligence has quickly moved from a novelty into a routine study aid in higher education. For engineering students, the appeal is especially strong because many academic tasks require iterative questioning, algorithmic reasoning, debugging, conceptual explanation, and the translation of symbolic or technical language into clear step-by-step guidance. Earlier higher-education reviews established that AI was already expanding across tutoring, assessment support, feedback, and learning analytics before the rise of large language models [1], [2]. Since the public release of ChatGPT, the debate has shifted from whether students will use conversational AI to how institutions should respond pedagogically, ethically, and structurally [3], [7]. Engineering education is a particularly important setting for this discussion. Students in engineering frequently work with complex theoretical abstractions, cumulative quantitative reasoning, programming tasks, and design-oriented problem solving. A system that can explain formulas, generate example code, summarize lecture material, and propose alternative solutions may improve efficiency and confidence. At the same time, the same system can create false fluency, conceal misconceptions, and encourage over-reliance if students accept outputs uncritically [3], [5], [7]. Thus, the educational value of ChatGPT in engineering likely depends not only on availability, but also on how students question, verify, and interpret the tool's responses. The uploaded draft for this study indicates that ChatGPT use among the surveyed engineering students is not merely occasional; it is sustained, common, and academically purposeful.

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The results suggest that students rely on it most heavily for conceptual understanding, formula explanation, code writing and debugging, and exam preparation. At the same time, they report concerns about inaccurate answers, missing references, and the danger of shallow learning. These patterns align with the broader educational literature but also point to an engineering-specific profile of use, where technical assistance and reasoning support matter as much as writing support [6], [8], [12], [13]. Accordingly, this paper develops the draft into a complete manuscript that addresses five research questions: (1) How frequently do engineering students use ChatGPT for academic tasks? (2) What learning behaviors accompany their use of the system? (3) How do students perceive its impact on learning and problem solving? (4) What risks or concerns do they identify? and (5) What implications follow for responsible integration of generative AI in engineering education?

RELATED WORK

The pre-ChatGPT AI-in-education literature already documented the growing use of artificial intelligence across higher education. Zawacki-Richter et al. reviewed AI applications in higher education and found strong emphasis on tutoring, assessment, and administrative functions, but comparatively limited focus on educator-centered pedagogical integration [1]. Crompton and Burke later showed that AI research in higher education accelerated sharply in 2021–2022, underscoring the field's movement from isolated technical applications toward broader learning-system adoption [2]. Once ChatGPT appeared, reviews quickly highlighted both opportunity and risk. Kasneci et al. argued that large language models can support feedback, content generation, and personalized learning, while also posing serious concerns related to accuracy, bias, and over-trust [3]. Tlili et al. similarly

showed that public and scholarly reactions to ChatGPT in education were simultaneously enthusiastic and cautious, especially around ethics, quality control, and assessment integrity [4]. Lo's rapid review concluded that ChatGPT can function as a virtual tutor and instructional assistant, but that educational institutions must immediately revisit assessment design and policy because the system can generate false or fabricated information and facilitate academic misconduct [5].

Engineering-focused studies reinforce these dual findings. Qadir framed ChatGPT as both promising and risky for engineering education, emphasizing its value for explanation, ideation, and communication while warning that students may outsource reasoning and weaken authentic learning if the technology is used passively [6]. Bravo and Cruz-Bohorquez, in a qualitative engineering context, likewise found that chatbots can improve access to explanations and learning support but require careful pedagogical framing [8]. Fan, Deng, and Liu surveyed engineering students in China and reported positive effects on learning efficiency, initiative, and creativity, alongside persistent concerns about domain accuracy and the limited effect on actual academic performance [12]. Sell et al. further documented measurable benefits in engineering education while emphasizing the need for thoughtful implementation strategies [15]. Beyond engineering, large-scale and synthetic evidence also helps contextualize the present study. Ravšelj et al. reported a global survey of 23,218 higher-education students from 109 countries and territories, finding widespread student use of ChatGPT for brainstorming, summarization, and research support, together with strong demand for regulation and guidance [13]. Meta-analytic work by Deng et al. found overall positive effects of ChatGPT on academic performance, affective-motivational states, and higher-order thinking, although the authors cautioned against overgeneralization because the quality of experimental designs varies [10]. A later meta-analysis by Wang and Fan similarly found positive effects on learning performance, learning perception, and higher-order thinking, while showing that outcomes differ by course type, duration, and implementation design [11]. Collectively, the literature suggests three consistent themes. First, students perceive real utility in ChatGPT for explanation, drafting, and study support. Second, accuracy, plagiarism, and dependency remain persistent concerns. Third, the educational value of generative AI is shaped by institutional guidance, assessment redesign, and student AI literacy rather than by the tool alone [3], [7], [10], [14]. The present survey contributes to this literature by offering a focused engineering-student perspective grounded in both quantitative and qualitative results.

METHODOLOGY

This study uses a descriptive survey design with complementary qualitative analysis. The uploaded draft reports responses from 200 engineering students, most of whom were senior undergraduates and primarily drawn from ECE-related disciplines. The sample was predominantly within the 22–25 age range and included students from computer, electrical forces and machines, electronics and communications, and biomedical fields. The survey instrument combined demographic questions, usage-history questions, frequency-of-use items for academic tasks, sixteen Likert-scale perception statements scored on a five-point scale, and two open-ended questions eliciting perceived benefits and concerns. This structure is appropriate for capturing both the prevalence of tool use and the quality of students' engagement with the tool. The instrument addressed behaviors such as prompt refinement, follow-up questioning, critical evaluation, and external verification, allowing the study to distinguish between passive dependence and active academic use. The uploaded draft states that analysis included descriptive statistics, Cronbach's alpha for internal consistency, one-sample t-tests against a neutral midpoint of 3, Pearson correlations, and thematic analysis of open-ended responses. Because the file provided for this revision contains summarized outputs rather than the raw response spreadsheet, the present manuscript reports inferential statistics as documented in the draft and does not recompute tests that would require item-level data. This choice preserves transparency and avoids introducing unsupported numerical claims. The methodological intent of the study is therefore exploration and evaluation rather than causal. It provides a snapshot of how engineering students are incorporating ChatGPT into academic work, how critically they engage with it, and how they balance perceived benefit against perceived risk. In light of rapid generative-AI adoption, such descriptive evidence is valuable for informing classroom policy, curriculum design, and responsible-use guidance [7], [13], [14].

RESULTS

Adoption and Experience

The draft reports near-universal academic adoption of ChatGPT within the sample. Specifically, 98.8% of respondents reported using ChatGPT for academic purposes, while 96.5% indicated that they had used the tool for more than six months. These figures suggest that generative AI is no longer peripheral within this engineering chore. Instead, it appears to function as a normalized study aid embedded in routine academic practice. The source summary further indicates that most students used the free version of ChatGPT, while a smaller subgroup used paid access. This pattern is important because it reflects real-world adoption under typical student constraints. The draft also notes a modest descriptive advantage in perceived overall impact among paid-version users ($M = 4.28$) relative to Free/Not sure users ($M = 4.07$), implying that model capability, speed, or usage limits may shape perceived usefulness. Because subgroup raw data were not available, this difference is interpreted descriptively rather than inferentially.

Academic Usage Patterns

Students reported frequent use of ChatGPT across several core engineering tasks. Its strongest uses were concentrated in conceptual understanding, algorithm and formula explanation, coding support, and exam preparation. More procedural or document-oriented activities, such as solving numerical problems or preparing lab reports, were used less consistently. The pattern suggests that students value ChatGPT most when it operates as a conversational explainer and ideation partner rather than as a final-answer machine.

Table I confirms that ChatGPT is used primarily as a conceptual learning assistant and programming support tool. This is consistent with prior engineering studies reporting that students value generative AI most when they can interrogate it iteratively, ask clarifying questions, and use it to unpack difficult technical material [6], [8], [12], [15].

Table I. dominant frequency of ChatGPT use across academic tasks

Activity	Dominant Frequency
Understanding theoretical concepts	Often / Very Often
Explaining formulas or algorithms	Often / Very Often
Writing or debugging code	Very Often
Exam preparation	Often
Generating project ideas	Often
Solving numerical problems	Sometimes
Preparing lab reports	Sometimes

Perception Measures

The perception results indicate a broadly positive attitude toward ChatGPT as a learning aid. All reported means exceeded the neutral midpoint of 3, suggesting that students generally saw the system as beneficial rather than harmful when used for academic support. However, the pattern across items is more informative than the simple positivity of the averages.

Table II. Selected Perception Measures (N = 200 Unless Otherwise Noted in the Draft)

Item	Mean	SD
Refine prompts	4.10	1.03
Ask follow-up questions	4.35	0.93
Critically evaluate answers	3.79	1.16
Verify with external sources	3.66	1.14
Break down complex problems	4.02	1.11
Improves confidence	4.14	1.06
Supports brainstorming	4.15	1.14
Positive overall impact	4.16	1.10
Recommend guided use	4.14	1.06

Two aspects of Table II deserve particular emphasis. First, the highest mean is associated with asking follow-up questions (M = 4.35), which suggests that students are not interacting with ChatGPT as a one-shot answer generator only. Many appear to be using it dialogically, refining and extending queries during study. Second, verification with external sources has the lowest reported mean among the listed positive behaviors (M = 3.66). This still exceeds neutrality, but it indicates that source-checking is less strongly embedded than questioning, brainstorming, or confidence-building. That imbalance matters because verification is one of the most important safeguards against hallucinated or incomplete technical guidance [3], [5], [7], [14].

Reliability, Inferential Findings, and Correlations

The draft reports Cronbach's $\alpha = 0.835$ for the perception instrument, indicating good internal consistency for the survey scale. This level of reliability supports the use of the instrument for summarizing student attitudes and suggests that the perception items measure a reasonably coherent construct.

Table III. Correlation of Selected Variables with Perceived Overall Impact

Variable	r
Recommend guided use	0.69
Allow as learning aid	0.60
Compare multiple solutions	0.44
Critically evaluate answers	0.43
Policy awareness	0.37
Avoid misuse	0.33
Break down problems	0.30

For inferential testing, the uploaded draft reports that the key variable representing overall impact was significantly above the neutral midpoint, with $t = 9.6$ and $p < 0.001$. Similar significance at $p < 0.001$ was reported for allowing ChatGPT as a learning aid, recommending guided use, and confidence improvement. Because only summarized test results were included in the draft and the raw response file was not available, this paper preserves those inferential findings as source-reported results rather than recomputing them.

The correlation structure in Table III suggests that students who see greater value in ChatGPT are not necessarily the least critical users. On the contrary, higher perceived benefit is associated with support for guided use, acceptance of ChatGPT as a learning aid, and behaviors related to comparing alternatives and critically evaluating answers. This pattern is important because it challenges a simplistic assumption that stronger endorsement of generative AI automatically signals naïve dependence. In this sample, positive educational value appears to coexist with at least some degree of critical engagement.

Qualitative Themes

The open-ended responses help explain why the quantitative results are positive despite ongoing concern. Students most frequently described ChatGPT as useful for simplifying difficult concepts, providing step-by-step explanations, helping with coding tasks, summarizing materials, generating project ideas, and saving time. These comments portray ChatGPT as a flexible cognitive support tool that reduces friction in early- and mid-stage learning tasks. At the same time, respondents repeatedly pointed to inaccurate or fabricated information, weak referencing, over-dependence, and a false sense of understanding as major risks. Several comments specifically suggested that ChatGPT can be misleading in advanced mathematics, circuits, and technically demanding problem-solving contexts. These concerns are consistent with the lower score for source verification relative to other positive-use behaviors, and they reinforce the view that perceived usefulness does not eliminate the need for structured skepticism.

DISCUSSION

The central result of this study is that ChatGPT has become a normalized academic support tool among surveyed engineering students, but not one they view uncritically. The strongest use cases in this cohort concept explanation, formula interpretation, coding support, and exam preparation fit the architecture of the tool well. Engineering students often need iterative, low-stakes clarification while moving between lectures, notes, equations, examples, and code. ChatGPT offers that kind of conversational scaffolding with unusually low access barriers. In this sense, the strong positive ratings reported here are unsurprising. More important is the kind of positive use being reported. The high means for asking follow-up questions, refining prompts, and breaking down complex problems suggest that students are using ChatGPT dialogically. This matters pedagogically because dialogic use is closer to guided tutoring than to answer outsourcing. The correlation results strengthen this interpretation: students who perceive greater benefit are also more likely to support guided institutional use and to report comparing or critically evaluating responses. These findings align with Qadir's

argument that the educational value of generative AI depends heavily on how learners interact with it, not merely whether they have access to it [6]. The results also align with broader empirical work. Bravo and Cruz-Bohorquez found that AI chatbots can support engineering learning when framed as aids rather than replacements [8]. Fan et al. observed that engineering students in China reported gains in learning efficiency and creativity but remained concerned about reliability and actual performance impact [12]. The large-scale global study by Ravšelj et al. likewise found widespread student use combined with concerns about cheating and a need for regulation [13]. The present survey therefore fits an emerging consensus: generative AI is useful to students, but its educational legitimacy depends on guardrails, literacy, and task design. At the same time, the present study highlights a persistent tension between confidence and verification. Students report that ChatGPT improves confidence and supports brainstorming, yet external verification receives a comparatively lower mean. This is precisely where educational risk can emerge. A system that provides fluent, plausible responses can create the feeling of understanding even when the explanation is incomplete or incorrect. In engineering, where small conceptual errors can propagate into major design or computational mistakes, this tension is not trivial. It helps explain why academic-integrity and assessment scholars continue to argue for policy revision, transparency requirements, and new forms of assessment in the ChatGPT era [5], [7], [14].

Table IV. Alignment of the Present Findings with Prior Literature

Study	Context	Alignment with Present Study
Qadir (2023)	Engineering education conceptual paper	Explains why ChatGPT is attractive for explanation, ideation, and communication, but warns against dependence and weakened reasoning.
Bravo & Cruz-Bohorquez (2024)	Engineering learning context	Supports the view that AI chatbots can enhance learning support when used as guided aids rather than replacements.
Fan et al. (2025)	148 engineering students in China	Finds positive effects on efficiency and creativity, but persistent concerns over reliability and limited direct performance gains.
Ravšelj et al. (2025)	Global higher-education student survey	Shows widespread student use and demand for regulation, consistent with present findings on adoption and policy relevance.
Deng et al. (2025) [10]; Wang & Fan (2025)	Meta-analytic evidence	Indicates overall positive average effects of ChatGPT on learning outcomes, but with important design and moderation caveats.

IMPLICATIONS FOR ENGINEERING EDUCATION

The findings support a strategy of guided adoption rather than blanket restriction. First, engineering programs should explicitly teach AI literacy as part of technical learning practice. This includes prompt formulation, asking follow-up questions, recognizing hallucinations, verifying outputs against authoritative sources, and documenting how AI assistance was used in coursework. These practices convert ChatGPT from a shortcut into a reflective learning tool [3], [5], [14]. Second, instructors should redesign at least some assessments to make student reasoning visible. Oral explanations, iterative drafts, design notebooks, code walk-throughs, in-class validation tasks, and reflection statements can reduce the educational value of merely copying AI output. Such formats are especially relevant in engineering because they emphasize process, justification, and trade-off analysis rather than polished text alone [5], [7], [14]. Third, institutions should provide clear policy language that distinguishes acceptable support from misuse. Students are already using these tools on a scale; ambiguity simply shifts risk onto learners and instructors. Clear expectations around attribution, verification, and prohibited outsourcing can help align institutional integrity policies with actual student behavior [7], [13], [14]. Finally, engineering educators should not assume that all AI use is equivalent. The present results suggest that students derive real value from concept clarification, debugging support, and brainstorming. Policies that prohibit all forms of AI use may eliminate beneficial scaffolding while failing to cultivate the evaluative skills students need in AI-rich professional environments. The better goal is supervised competence, not artificial separation from the tool.

CONCLUSION

This study provides evidence that ChatGPT is deeply embedded in the academic practices of the surveyed engineering students. Students report sustained and frequent use, especially for conceptual clarification, programming support, formula explanation, and exam preparation. The perception results are strongly positive overall, the scale reliability is good, and the qualitative responses show that many students see ChatGPT as a practical and confidence-building learning assistant. However, the same students also identify nontrivial risks, including inaccurate responses, missing references, over-dependence, and the possibility of mistaking fluent output for genuine understanding. The most important implication is therefore not whether engineering education should engage with generative AI, but how. The evidence from this study supports guided use grounded in verification, transparency, prompt literacy, and assessment redesign. When those conditions are present, ChatGPT can function as a productive supplement to engineering learning. When they are absent, the tool may encourage speed without depth. The task for engineering education is to preserve the former while constraining the latter.

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