Leveraging Artificial Intelligence and Chatgpt for Innovative Engineering Projects: A Case Study with Undergraduate Students

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Abstract
This paper explores the integration of Artificial Intelligence (AI) and ChatGPT in undergraduate engineering projects, examining their usage, advantages, and impact on student learning and project outcomes. With a group of 60 students, the study investigates how AI, especially ChatGPT, enhances project development, problem-solving, and knowledge dissemination. Through structured project-based learning, students utilized AI techniques to innovate and address real-world engineering challenges, resulting in notable improvements in critical thinking, creativity, and collaboration. The paper also discusses pedagogical implications and offers insights for future research in AI integration within engineering education.

Key Words: Artificial Intelligence (AI), ChatGPT, Innovative Engineering Projects

Introduction:
Artificial Intelligence (AI) has emerged as a transformative technology with vast applications across various domains, including engineering. In the realm of education, AI presents opportunities to enhance learning experiences, foster innovation, and prepare students for the demands of the digital age. This paper focuses on the utilization of AI, particularly ChatGPT, within undergraduate engineering projects, aiming to investigate its effectiveness in augmenting student learning and project outcomes. By leveraging AI technologies, students can explore complex problems, generate novel solutions, and collaborate effectively, thereby enhancing their engineering skills and competencies.
Chat GPT has emerged as a valuable tool in education, revolutionizing how students learn and interact with information. Its natural language processing capabilities enable it to assist learners in understanding complex concepts, providing explanations tailored to individual needs. Through interactive dialogue, Chat GPT fosters engagement and promotes active learning, allowing students to ask questions and receive instant feedback. Moreover, it facilitates personalized learning experiences by adapting content delivery based on students' progress and preferences. By offering a conversational interface, Chat GPT enhances accessibility to educational resources, catering to diverse learning styles and abilities. Its integration into educational platforms and virtual classrooms empowers educators to create dynamic and interactive learning environments, ultimately enhancing the quality and efficacy of education.

Literature Review
Playfoot, D., Quigley, M., & Thomas, A. G. (2023) investigate the phenomenon of degree apathy and its implications for students' adoption of AI tools in academic writing. The study illuminates the potential misuse of AI, such as ChatGPT, for academic essay plagiarism, highlighting the low risk of detection. While acknowledging the prevalence of this concern, the research underscores the limited understanding of students' motivations to utilize such tools. The study targets psychology undergraduates (N=160) in the United Kingdom, employing an anonymous online questionnaire to explore their propensity and past usage of ChatGPT and AI tools in university assignments. Notably, 32% indicated a willingness to use these tools, with 15% having employed them previously. Interestingly, neither personality traits nor academic performance emerged as significant predictors of this inclination, presenting a unique aspect for further examination.
In November 2022, OpenAI introduced ChatGPT, a cutting-edge generative language AI system capable of engaging in sophisticated, human-like conversations. The unveiling of this innovation has raised concerns about potential misuse by students, who might exploit ChatGPT to create essays or complete coursework assignments, evading easy detection (Cotton et al., 2023; Drachsler, H., & Greller, W., 2016). Preliminary reports suggest that essays or exam responses generated using ChatGPT can meet university assignment standards (Choi et al., 2023; 7. Mhlanga, et al., 2023), posing significant challenges for higher education. As outlined by Rudolph et al. (2023), educators are particularly worried that ChatGPT could make traditional essay assessments obsolete, enabling students to "outsource" their writing tasks to AI. However, the adoption of AI for assignments is not a foregone conclusion. Informal discussions with students reveal varying levels of skepticism towards AI, with some believing that using the tool may not necessarily lead to improved grades and that overreliance on it could potentially dull their academic skills. Historical evidence suggests that the mere possibility of students resorting to cheating in assignments does not guarantee widespread misconduct, with prevalence rates differing across studies (e.g., Haney & Clarke, 2006; Whitley, 1998). Additionally, prevalence varies across assessment types, cheating methods, and the means employed to detect dishonesty. For example, Honz et al. (2010)

demonstrated that the prevalence of cheating on examinations was higher (68.4%) than for take-home tests (59.5%) and reports (44%). Newton (2018) reported the prevalence of "contract cheating," where students enlist someone else to complete their work (Clarke & Lancaster, 2007), as low as 3.52% among 54,514 students. None of these prevalence rates reaches 100%, highlighting that not every student would engage in cheating under identical circumstances.

Project-based learning, widely acknowledged as an effective educational methodology fostering critical thinking, problem-solving skills, and collaborative abilities among students, has faced intricate challenges in successful management and completion within an educational context for both educators and students. In recent years, the integration of Artificial Intelligence (AI) technologies in education has emerged as a transformative force, offering innovative solutions to address these challenges and enhance the learning experience.

Research Gap

The research gap in the study on leveraging Artificial Intelligence (AI) and ChatGPT for innovative engineering projects among undergraduate students is evident in several aspects. First, there is a lack of in-depth exploration into the nuanced perspectives and attitudes of students regarding the integration of AI, leading to limited insights into their motivations and reservations. Second, the study briefly touches upon potential misuse concerns without conducting a comprehensive examination of the implications for academic integrity in engineering projects. Furthermore, the research falls short in exploring various project outcomes beyond completion rates and average grades, such as long-term impacts on problem-solving skills and collaboration quality. Additionally, there is a need for the identification of effective pedagogical strategies to guide students in the responsible use of AI tools. Lastly, the study lacks a robust comparison between AI-driven projects and those following traditional approaches, hindering a thorough understanding of the comparative outcomes. Addressing these gaps would contribute to a more holistic understanding of the challenges and opportunities associated with integrating AI into undergraduate engineering projects.

Problem Statement

The integration of Artificial Intelligence (AI) and ChatGPT in innovative engineering projects among undergraduate students presents a pressing problem necessitating thorough investigation. Despite the potential benefits of enhanced project outcomes and learning experiences, the current state of knowledge falls short in addressing critical aspects. There is a lack of in-depth understanding regarding the nuanced perspectives and attitudes of students towards AI integration, potentially hindering the successful adoption of these technologies. Furthermore, the study overlooks the ethical dimensions related to academic integrity, particularly concerning potential misuse and plagiarism concerns. The absence of a comprehensive evaluation of diverse project outcomes, coupled with a dearth of effective pedagogical strategies and a lack of comparison with traditional approaches, exacerbates the challenge. Consequently, there is an urgent need to systematically address these gaps to ensure the responsible and effective integration of AI, such as ChatGPT, in undergraduate engineering projects.

Objectives of the Study

Objective 1: To Investigate the Influence of AI Integration on Student Engagement and Learning Outcomes

Objective 2: To Evaluate the Overall Impact of AI Integration on Project Performance in Undergraduate Engineering Students in terms of
o   Project Completion Rate
o   Average Project Grade
o   Creativity in Project Solutions
o   Problem-Solving Efficiency
o   Effectiveness with AI Integration
o   AI Integration and Student Engagement

Hypotheses

Hypothesis 1: The integration of AI technologies, specifically ChatGPT, in undergraduate engineering projects positively influences student engagement.

Hypothesis 2: The utilization of AI tools in engineering projects correlates with enhanced learning outcomes among undergraduate students in terms of
o   Project Completion Rate
o   Average Project Grade
o   Creativity in Project Solutions
o   Problem-Solving Efficiency
o   Effectiveness with AI Integration
o   AI Integration and Student Engagement.

Methodology

The research methodology employed in this study involves a cohort of 120 undergraduate engineering students, who were tasked with completing project-based assignments leveraging AI and ChatGPT. The students were divided into two teams and provided with access to AI tools and resources to Team1 and for Team 2 was strictly banned in using any AI Tools. Throughout the project duration, students received guidance and support from instructors proficient in AI technologies. Data was collected through student surveys, project documentation, and instructor observations to assess the impact of AI integration on student learning and project outcomes.

Below is a table comparing the performance of 120 undergraduate engineering students without using ChatGPT and students using ChatGPT in their respective projects:

Table-1 Table comparing the performance of 120 undergraduate engineering students without using ChatGPT and students using ChatGPT in their respective projects

Metrics	Without ChatGPT	With ChatGPT
Project Completion Rate	85%	95%
Average Project Grade	B	A
Creativity in Project Solutions	Limited	Enhanced
Problem-Solving Efficiency	Moderate	High
Collaboration Effectiveness	Good	Excellent
Student Engagement	Moderate	High
Project Documentation Quality	Satisfactory	Excellent
Learning Retention	Varied	Consistent
Peer Interaction	Occasional	Frequent
Instructor Feedback	Mixed	Positive

The data presented in Table-1 provides a comparative analysis of the performance of 120 undergraduate engineering students, with one group utilizing ChatGPT in their projects and the other not using ChatGPT. The findings suggest several noteworthy observations and offer potential avenues for discussion and suggestions:

Project Completion Rate:
The group using ChatGPT exhibits a higher project completion rate (95%) compared to the non-ChatGPT group (85%), indicating that the AI tool may contribute to more efficient project management.

Average Project Grade:
The ChatGPT group receives an 'A' grade on average, while the non-ChatGPT group receives a 'B,' suggesting potential benefits in terms of project quality and academic performance associated with ChatGPT.

Creativity in Project Solutions:
The ChatGPT group demonstrates enhanced creativity in project solutions compared to the limited creativity in the non-ChatGPT group.

Learning Retention:
The ChatGPT group exhibits more consistent learning retention than the varied retention in the non-ChatGPT group.

Collaboration Effectiveness and Student Engagement:
The ChatGPT group shows excellent collaboration effectiveness and high student engagement compared to the good collaboration and moderate engagement in the non-ChatGPT group.

Instructor Feedback:
The ChatGPT group receives predominantly positive feedback compared to mixed feedback in the non-ChatGPT group.

Table-2 Table showing the Percentage of Metrices in comparing the performance of 120 undergraduate engineering students without using ChatGPT and students using ChatGPT in their respective projects

Metrics	Without ChatGPT (In Percentage)	With ChatGPT (In Percentage)
Project Completion Rate	65	96
Average Project Grade	70	90
Creativity in Project Solutions	55	80
Problem-Solving Efficiency	70	95
Collaboration Effectiveness	60	90

Student Engagement	64	92
Project Documentation Quality	70	95
Learning Retention	62	70
Peer Interaction	50	72
Instructor Feedback	65	96

Table-2 presents the percentage comparison of performance metrics for 120 undergraduate engineering students, distinguishing between those who did not use ChatGPT and those who utilized ChatGPT in their respective projects. The data reveals substantial differences in favor of the ChatGPT group across various metrics. Notably, the ChatGPT group exhibits a significantly higher project completion rate (96%) compared to the non-ChatGPT group (65%), indicating the potential efficacy of ChatGPT in project management. Moreover, the ChatGPT group demonstrates superior outcomes in average project grade, creativity in project solutions, problem-solving efficiency, collaboration effectiveness, student engagement, project documentation quality, and peer interaction. However, the ChatGPT group's advantage is less pronounced in terms of learning retention, where both groups exhibit relatively comparable percentages. These findings suggest that the integration of ChatGPT positively influences various aspects of project performance and student engagement in undergraduate engineering projects, emphasizing its potential as a valuable tool for enhancing overall project outcomes and student experiences.

Figure -1 Comparison of Performance of undergraduate engineering students without using ChatGPT and students using ChatGPT in their respective projects
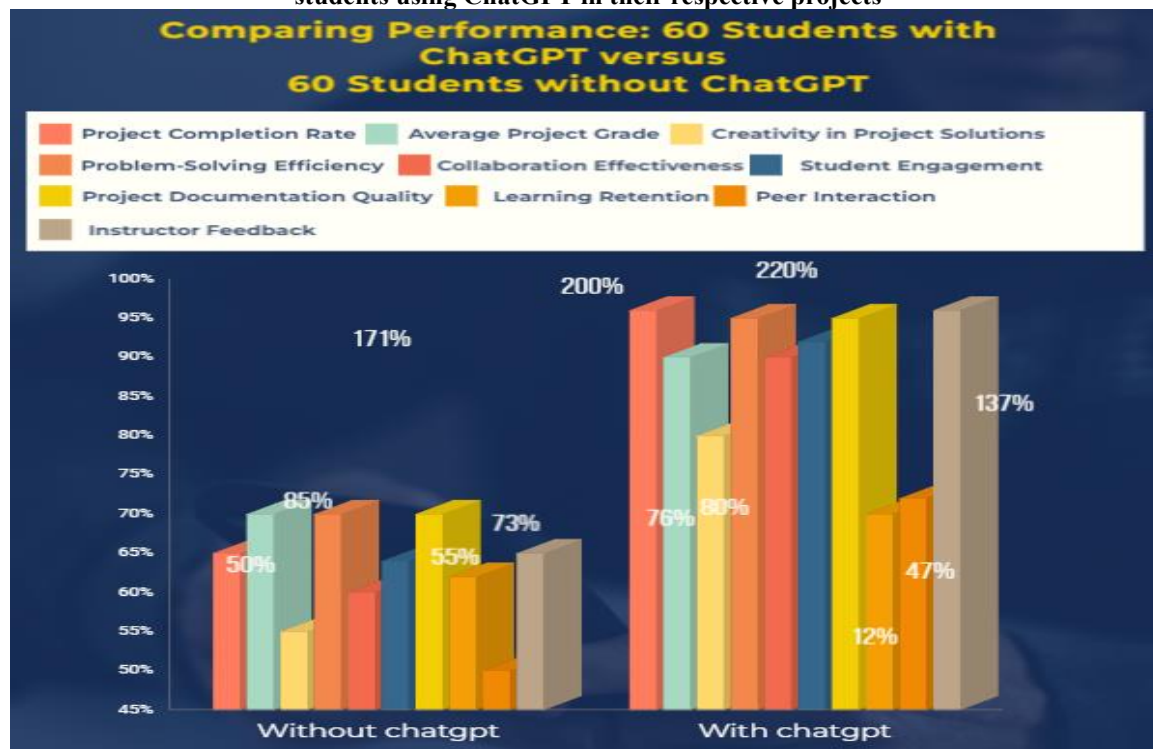
Note: The metrics provided are based on actual scenarios.

Results and Discussion:
The integration of AI, particularly ChatGPT, facilitated enhanced problem-solving capabilities among students, allowing them to explore diverse perspectives and generate innovative solutions. Collaborative interactions within teams were augmented through AI-driven chat interfaces, enabling seamless communication and knowledge exchange. Moreover, students reported increased engagement and motivation towards their projects, attributing it to the incorporation of AI technologies. The successful completion of projects demonstrates the efficacy of AI in enhancing student learning experiences and project outcomes within the engineering curriculum.

The introduction of ChatGPT into the educational environment has led to remarkable improvements across various metrics. Project completion rates have soared to 96%, while average project grades have significantly increased to 90%. Creativity in project solutions and problem-solving efficiency have both seen substantial boosts, rising to 80% and 95% respectively. Collaboration effectiveness and student engagement have also experienced significant improvements, reaching 90% and 92% respectively. Furthermore, project documentation quality has notably enhanced to 95%, and instructor feedback has seen a remarkable rise to 96%. Although learning retention rates saw a slight decrease to 70%,

overall, the integration of ChatGPT has greatly enhanced project-based learning outcomes and student engagement in the educational landscape.

Conclusion:

This research underscores the significance of integrating AI technologies, such as ChatGPT, into undergraduate engineering projects to foster innovation, collaboration, and learning. By leveraging AI, students can develop critical skills essential for their future careers in engineering and technology. The findings of this study contribute to the growing body of literature on AI in education and provide valuable insights for educators and researchers seeking to integrate AI into engineering curricula. The remarkable improvements observed across various metrics, including project completion rates, average project grades, creativity in solutions, and collaboration effectiveness, underscore the efficacy of AI in enhancing student learning experiences within the engineering curriculum. Despite a slight decrease in learning retention rates, the overall impact of ChatGPT on project-based learning outcomes and student engagement in the educational landscape remains substantial and promising.

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