

## **Enhancing Education Through Thoughtful Integration of Large Language Models in Assigned Work**

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### Abstract

In a world where technology is evolving rapidly, it is essential to note its significant intrusion into the field of education. Technology has made vast amounts of information accessible to students, making them over-reliant on technology and less reliant on nurturing their knowledge and imagination. While limiting technology's usage is impossible to stop, learning how to incorporate it efficiently in the educational system is essential. Integrating machine learning (ML) and artificial intelligence (AI) in education is a significant shift in educational methodologies. This transformation offers the possibility to change learning approaches while presenting challenges in the ethical field. This research paper explores the impact of machine learning (ML) and artificial intelligence (AI), particularly large language models like Chat GPT, on education in our classrooms. This topic is essential because it signifies a change in the methods that educators and students use to engage in a course, transforming the learning outcomes while upholding ethical principles. The application of ML and AI in education has attracted increasing attention, but the long-term effects of these technologies on learning achievements require further investigation. Therefore, we aim to find an approach that allows the integration of ML and AI, specifically Chat GPT, while maintaining high expectations in our classrooms. While tools like Chat GPT hold transforming educational potentials, their integration must be navigated thoughtfully, balancing technological advancements with concept learning and acquisition. In this paper, we utilize quantitative analysis of educational outcomes and observational research to understand the impact of LLM on Education. We will observe firsthand how these technologies are integrated into the classroom and how they affect teaching and learning dynamics.

### Introduction

The rapid evolution of technology has undeniably made its mark on various sectors, and education being one of the most significantly impacted areas<sup>1</sup>. Multiple industries have adopted artificial intelligence (AI) and machine learning (ML) making a statement in innovation<sup>2</sup>. These Large Language Models (LLMs) have achieved great success in several learning tasks, including image recognition<sup>3</sup> and speech processing<sup>4</sup>. The incorporation of ML and AI in educational settings predicts a new era of teaching and learning methodologies<sup>5</sup>, fundamentally altering the traditional

dynamics of classrooms. This paper discusses the relationship between large language models like Chat GPT and their effects on educational approaches. The goal is to incorporate technology in a way that improves learning while maintaining ethical principles and the human touch in education. We must assess ML and AI's opportunities and challenges in shaping education's future. This paper aims to explore how these technologies introduced in specific ways to certain classes influence student psychological well-being, ethical considerations, cognitive skills, pedagogical learning, and the fundamental nature of learning to provide insights into creating a balanced and effective educational ecosystem in the modern digital age.

## Background

In recent years, the integration of Large Language Models (LLMs) into educational settings has gained considerable attention for its potential to enhance learning experiences and foster practical skills<sup>6</sup>. This paper explores the application of LLMs in two distinct computer science courses, CSCE 331 (Introduction to Software Engineering) and CSCE 412 (Cloud Computing).

### *CSCE 331: Leveraging LLMs in Software Engineering Education*

In CSCE 331, an introductory course to software engineering, students are tasked with assignments designed to showcase the valuable capabilities of LLMs. The first assignment challenges students to build a professional presence web page, accompanied by an additional page generated by the LLM on any given topic. This not only exposes students to the efficiency of LLMs in content creation but also provides a basis for comparison between human-generated and model-generated content.

The second assignment in CSCE 331 involves integrating LLMs into the software development process for a Point of Sale (POS) system for a local restaurant. Students are required to use the LLM to automatically generate JavaDoc comments for the written code, which can then be published on a local web server. This hands-on approach not only educates students on the effective utilization of LLMs in software documentation but also underscores the potential time-saving benefits in real-world software development scenarios.

### *CSCE 412: Exploring LLMs in Cloud Computing Projects and Exams*

In CSCE 412, an advanced computer science course focusing on load balancer design in C++, students are encouraged to leverage LLMs for specific aspects of their projects. While students are tasked with designing the load balancer to meet specified requirements, they are also given the freedom to use LLMs for small routine or function generation, aiding in code completion and efficiency. Additionally, LLMs are employed to assist in debugging procedures, such as identifying and resolving issues like infinite loops.

However, the integration of LLMs in CSCE 412 poses challenges in the examination setting. Recognizing the LLM's proficiency in problem-solving and argumentative skills, particularly in open-book scenarios, the decision was made to revert to handwritten exams without computer access. This adjustment ensures that students engage in critical thinking and problem-solving independently, thus preserving the integrity of the assessment process.

## **Integrating Psychological Theories and Cognitive Strategies in Learning**

### *Self-Motivation and Self-Efficacy*

The integration of an LLM, like ChatGPT, into educational settings has the potential to enhance motivation and self-efficacy among students<sup>1</sup>, but excess use of these resources can yield adverse effects. Students' cognitive skills rely on their self-efficiency and self-motivation. Studies have shown that the lower their motivation and self-efficacy to acquire cognitive skills, the higher their avoidance of tasks. In contrast, those with higher motivation, self-efficacy, and self-motivation are likely to engage with tasks using their knowledge and expand their borders<sup>7</sup>. LLMs could restrict students from reflecting on their learning process; instead, students might overlook their strengths and areas for improvement. LLMs could suppress the development of a growth mindset<sup>8</sup> by providing immediate answers or solutions without requiring students to consider their approach to a problem, the potential strategies, or takeaways. This lack of reflective practice could diminish students' metacognitive skills, making them less effective learners.

### *Self-Awareness and Self-Regulation*

Self-awareness is promoted by recognizing the complexities of human thought, such as cultural delicacy and emotional depth, that LLMs might not fully capture. At the same time, self-regulation affects applying strategies to verify the accuracy and reliability of this content. Zimmerman and Moylan discuss the intersection of metacognition and motivation, which is crucial in promoting self-awareness and self-regulation in students when evaluating Large Language Models<sup>9</sup>. Promoting this with tools like ChatGPT pushes educators to hold students accountable to critically assess and understand AI-generated content's limitations and potential inaccuracies. Students should be encouraged to question the information, cross-reference facts, and not substitute critical thinking with automated responses, thus developing a disciplined approach to learning and a habit of deeper inquiry. This balanced perspective on using LLMs, cultivated through educational practices, enhances students' cognitive abilities. It prepares them to navigate digital information with understanding and critical thinking, ensuring the balance between reaping the benefits of these tools without undermining their independent thinking skills.

### *Empathy and Social Skills*

While ChatGPT and multiple LLMs can simulate conversations and provide informative content, they cannot fully replicate human exchanges' emotional depth and social skills. This gap can diminish students' ability to engage in empathetic interactions and effectively navigate social situations. The absence of non-verbal cues, emotional intonation, and the dynamic context of real-life conversations in LLM-mediated interactions could reduce students' social and emotional learning. Cognitive science has increasingly embraced the 4E cognitive science paradigm, highlighting embodied, embedded, enactive, and extended nature. Excessive use of LLMs raises concerns about its potential impact on these crucial aspects of human cognition and learning<sup>10</sup>. To mitigate these effects, educators can incorporate face-to-face interactions and group activities to promote these crucial skills for student development. They can encourage reflective practices, such as discussing the emotional aspects of communication in class and conveying to students that technology serves as a facilitator and guide rather than an eraser of social features.

### *Emotional Intelligence*

We can agree that all aspects mentioned in this section can lead to one trait: emotional intelligence. While it is important for students to acquire a specific skill set geared toward their field of study, nourishing their emotional intelligence is equally as important. Human emotional intelligence can "recognize, understand, manage, and use emotions in positive ways to relieve stress, communicate effectively, empathize with others, overcome challenges, and defuse conflict," a human-centric trait that current technology, including the most advanced machine learning models, cannot fully replicate<sup>11</sup>. While LLMs have made significant steps in recognizing and mimicking human emotional expressions, the depth, delicacy, and complexity of accurate emotional intelligence remain uniquely human attributes.

### *Academic Integrity*

The utilization of LLMs in assigned coursework raises important ethical considerations regarding academic integrity and the promotion of independent learning. While LLMs offer valuable assistance in various tasks, including content generation, code completion, and problem-solving, their use must be governed by clear guidelines to uphold academic honesty and ensure equitable evaluation. In instances where LLMs are not permitted, students must adhere to established policies and refrain from utilizing these tools to maintain the integrity of assessments. Educators play a crucial role in articulating clear guidelines for LLM usage, emphasizing the importance of original thought, critical analysis, and independent problem-solving skills. Moreover, fostering an environment that values transparency and accountability in academic practices can mitigate potential ethical dilemmas associated with LLM integration<sup>12</sup>. By promoting ethical behavior and providing students with the necessary support and resources, educators can harness the benefits of LLMs while upholding the principles of academic integrity and fostering a culture of responsible learning.

## **Pedagogical Learning Processes**

### *The Importance of Student Resourcefulness*

Cultivating resourcefulness in students is becoming increasingly essential in modern educational environments, particularly in rapidly advancing technologies. Resourcefulness is a key attribute in navigating both structural and academic challenges, emphasizing the importance of developing such skills in the context of utilizing AI tools in education<sup>13</sup>. In today's classrooms, the ability to use tools like ChatGPT effectively is not just an added advantage but a necessity. This claim is valid in disciplines such as computer programming<sup>14</sup>, where a deep understanding of the subject matter goes hand in hand with the practical application of technological tools. Integrating LLMs into assignments serves a dual purpose: it familiarizes students with cutting-edge technology while reinforcing the critical learning objectives of the curriculum. This approach fosters resourcefulness by pushing students to rely on AI-generated solutions and understand the underlying principles that guide these solutions.

### *Understand Code Thoroughly*

In programming education, the objective exceeds the final destination, correct solutions; it encloses a profound comprehension of the underlying mechanisms. Students' use of LLM as an assistive tool for their assignments necessitates a simultaneous understanding of the code's functionality and the

principles behind its operation. In this context, post-assignment handwritten exams are a strategic pedagogical intervention to consolidate learning and facilitate a deeper engagement with the subject matter. For instance, using an LLM to generate code snippets can expedite the development process, but students must first understand the logic behind the code to implement and troubleshoot it effectively. This balance between leveraging LLM and nurturing a deep understanding of the subject matter is pivotal in preparing students for the complexities of the modern technological landscape.

### *Pedagogical Measures*

Exploring the methodologies students utilize in completing assignments and understanding their reasoning can enhance engagement with the subject matter. Integrating out-of-class learning activities, such as multi-day team projects, helps to address the limitations of in-class learning<sup>15</sup>. Nevertheless, teaching strategies can influence the effectiveness of out-of-class learning when applied within the classroom. This interplay between in-class and out-of-class learning experiences offers a unique opportunity to deepen knowledge acquisition<sup>16</sup>. Given the challenges in quantifying the impact of external resources, such as LLMs, on learning outside the classroom, designing the in-class environment to optimize educational outcomes strategically is crucial. Educators can implement questioning strategies to authenticate that students are not merely bypassing the learning process but are actively engaging with and learning from the code. Introducing questionnaires or reflective exams within this controlled setting promotes reflection and self-assessment among students, encouraging them to reconcile their autonomous learning efforts with the foundational concepts presented in the classroom, mitigating any overreliance on AI/ML. Our desire to incorporate post-assignment questionnaires into the academic curriculum is designed to improve educational results. By nurturing a profound connection with the subject matter and promoting a thoughtful approach to learning, educators can equip students to manage the learning of their respective fields, focusing on the critical examination and implementation of coding principles within the framework of the technology-oriented academic environment.

### *How to go Beyond Technology?*

The educational journey lies in leveraging these technologies not as definitive solutions but as springboards for human creativity. Educators should encourage students to use LLMs to spark creative ideas yet emphasize the irreplaceable value of human originality. This balanced approach ensures that technology supplements education, enhancing learning experiences while fostering the critical thinking and inventive skills necessary for students to navigate and shape the future. Human complexity surpasses any boundaries, including technology; it is essential to use human creativity and innovation as skills to enhance the intelligence of models like LLMs by priming LLMs with diverse and relevant data. Humans in nature are creative individuals; Gabora and DiPaola researched the computational foundations of creativity, concluding that neural network-based agents evolve ideas for actions through both invention and imitation, a concept that mirrors the inherent creativity of humans<sup>17</sup>. This perspective underlines the concept that humans are creative, with their innovative capacities being a blend of individual creativity and social behavior in which these ideas are disseminated and refined. Thus humans should influence the data present instead of relying on it and limiting their innovative horizon.

## Summary and Future Work

The integration of Large Language Models (LLMs) in educational settings presents both opportunities and challenges. This paper has explored the application of LLMs in specific computer science courses, highlighting their potential to enhance learning experiences while emphasizing the importance of maintaining ethical standards and preserving essential human elements of education. In courses such as CSCE 331 and CSCE 412, LLMs have been incorporated into assignments to demonstrate their capabilities in content creation, software documentation, and code generation. While these applications showcase the efficiency and practicality of LLMs in certain tasks, they also raise concerns regarding academic integrity, student motivation, and the development of critical thinking skills.

The paper discusses the psychological theories and cognitive strategies involved in learning with LLMs, emphasizing the importance of promoting self-awareness, self-regulation, empathy, and emotional intelligence among students. It also addresses the pedagogical measures necessary to ensure that the integration of LLMs enhances rather than undermines students' understanding and engagement with the subject matter. Furthermore, the paper suggests going beyond technology by emphasizing human creativity and innovation as essential skills in leveraging LLMs effectively. Educators are encouraged to cultivate a balanced approach that harnesses the benefits of LLMs while emphasizing the irreplaceable value of human originality.

Incorporating psychological, cognitive, ethical, and pedagogical practices into educational settings encourages a balanced perspective on using LLMs. It helps students leverage these tools' benefits while maintaining their ability to think independently and critically. Educators play a crucial role in modeling and teaching these skills, providing opportunities for students to engage with LLM-generated content in ways that promote thoughtful analysis and reflection. This approach enhances students' cognitive and metacognitive abilities and prepares them to navigate the complex landscape of digital information with understanding and responsibility.

Observing the use of Large Language Models (LLMs) in certain aspects of Software Design courses, future work will focus on enhancing these assignments while actively soliciting feedback from students regarding their perceptions of the risks and rewards associated with LLM integration. By refining and expanding upon the existing assignments, we aim to maximize the benefits of LLMs in enhancing learning experiences while addressing any concerns or challenges identified by students. This iterative approach will not only allow for continuous improvement in course design but also foster a collaborative learning environment where students' voices and perspectives are valued and integrated into the educational process.

## Conclusions

In conclusion, the integration of Large Language Models (LLMs) in educational settings represents a significant shift in teaching and learning methodologies. While LLMs offer valuable opportunities to enhance efficiency and effectiveness in certain tasks, their integration must be approached with

caution to ensure that ethical standards are maintained and essential human elements of education are preserved. By incorporating LLMs into specific courses, educators can expose students to cutting-edge technology while reinforcing critical learning objectives. However, it is essential to promote self-awareness, self-regulation, empathy, and emotional intelligence among students to mitigate potential pitfalls associated with excessive reliance on LLMs.

Moreover, educators must adopt pedagogical measures that foster a deep understanding of the subject matter and encourage critical thinking and creativity. By striking a balance between leveraging LLMs and emphasizing human creativity and innovation, educators can create a balanced and effective educational ecosystem that prepares students to navigate and shape the future effectively.

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