

# ChatGPT in the classroom: balancing transformative opportunities with pedagogical and ethical challenges

**Chukwuka Judith Nkolika<sup>1</sup>,**

<sup>1</sup>Department of Curriculum and Instructional Technology, Nwafor Orizu College of Education Nsugbe, No. 1 college road, Abata, Nsugbe 432108, Anambra, Nigeria

\*Correspondence: ✉ [judithchukwuka70@gmail.com](mailto:judithchukwuka70@gmail.com)

## Abstract

Large Language Models (LLMs) such as ChatGPT have rapidly emerged as permanent, irreversible fixtures in modern educational ecosystems, fundamentally reshaping traditional paradigms of teaching, learning, and scholarly inquiry. These generative conversational tools offer profound opportunities to revolutionize education through personalized learning pathways, dynamic student engagement, automated instructional feedback, and administrative workflow optimization.

However, fully capitalizing on these transformative benefits requires cultivating essential educational competencies among both learners and educators—particularly critical thinking, prompt engineering, rigorous fact-checking, and comprehensive AI literacy. Concurrently, the unchecked deployment of LLMs exposes critical operational challenges and complex socio-technical risks, including algorithmic bias amplification, academic dishonesty, student cognitive over-reliance, and persistent data privacy vulnerabilities.

To safely navigate this evolving landscape, educational institutions must adopt proactive governance frameworks, redesign process-oriented assessment models, bridge global digital equity divides, and maintain continuous human-in-the-loop oversight. Ultimately, by balancing visionary technological potential with actionable risk mitigation strategies, forward-looking policy can ensure that generative AI serves as an equitable, empowering scaffold for human intellectual growth.

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## Introduction

The rapid evolution of Natural Language Processing (NLP)—driven by transformer architectures, self-attention mechanisms, fine-tuning, and few-shot learning—has culminated in the widespread emergence of generative Artificial Intelligence (AI) systems such as ChatGPT. The unprecedented capability of Large Language Models (LLMs) to generate human-like text, formulate coherent essays, solve complex reasoning tasks, and execute computer code has triggered a profound paradigm shift within the modern educational landscape (Crompton & Burke, 2023; Gill & Kaur, 2023). As generative conversational agents become increasingly embedded in higher education environments, they offer transformative possibilities for redesigning instructional paradigms, expanding access to knowledge, and reimagining educational interactions (Dwivedi et al., 2023; Gill et al., 2023).

Despite this revolutionary potential, the deployment of LLMs in educational settings brings significant technical brittleness, ethical vulnerabilities, and systemic risks. The lack of model interpretability, alongside the tendency of LLMs to generate persuasive yet inaccurate output, poses epistemic threats to traditional assessment methods and undermines institutional trust (Benuyenah, 2023; van Dis et al., 2023). Furthermore, the unchecked integration of generative AI raises critical concerns regarding academic integrity, ethical boundaries in research and medical publishing, societal bias amplification, and privacy compliance (Bin-Nashwan et al., 2023; Liebrezn et al., 2023; Nam & Bai, 2023; Stahl & Eke, 2023; Yan et al., 2023). Addressing these high-level limitations is therefore essential to prevent generative tools from eroding core academic standards while harnessing their positive capabilities.

From the learner's perspective, generative AI opens multidimensional avenues for personalizing and enriching the educational experience. Functioning as an accessible virtual tutor and dynamic "more knowledgeable other," ChatGPT fundamentally alters students' academic help-seeking behavior by offering instant, tailored guidance across varied complex topics (Adams et al., 2023; Ding et al., 2023;

Stojanov, 2023). Empirical investigations demonstrate that interactive engagement with LLMs can stimulate students' cognitive skills, enhance intrinsic motivation, facilitate active knowledge creation, and optimize information retrieval within innovative instructional formats such as flipped classrooms (Essel et al., 2023; Lai et al., 2023; Lee et al., 2023; Wang et al., 2023).

The acceptance and utilization of these generative tools are strongly mediated by demographic factors, technology acceptance profiles, and domain-specific learning requirements. Generation Z students consistently exhibit higher interest and readiness to adopt generative AI in their learning routines compared to older cohorts, though their engagement is heavily shaped by their underlying expectations and perceived utility of the technology (Chan & Hu, 2023; Chan & Lee, 2023; Chan & Zhou, 2023). Across diverse academic disciplines—ranging from engineering problem-solving to second language (L2) writing and feedback—students utilize ChatGPT to scaffold complex tasks, navigate language anxiety, and improve writing efficiency, while simultaneously expressing nuanced concerns regarding ethical boundaries and detection chances (Bernabei et al., 2023; Dakakni & Safa, 2023; Escalante et al., 2023; Farhi et al., 2023).

From the teaching perspective, generative AI serves as a powerful workflow catalyst that redefines instructional design, content generation, and pedagogical communication. Educators and researchers increasingly leverage LLMs to streamline lesson planning, automate exercise creation, and generate adaptive diagnostic feedback that supports student revisions (Ali et al., 2023; Labadze et al., 2023; Tlili et al., 2023). When integrated into writing-intensive courses, AI-assisted feedback mechanisms provide actionable, personalized suggestions that complement human instruction, fostering dynamic co-writing environments between students and teachers (Barrett & Pack, 2023; Escalante et al., 2023).

Ultimately, navigating the intersection of opportunities and challenges necessitates a structured, proactive policy framework and a comprehensive vision for AI literacy across educational systems. Rather than viewing the technical limitations and ethical pitfalls of LLMs as insurmountable barriers, educators can convert these vulnerabilities into vital pedagogical opportunities to teach critical thinking, fact-checking, and responsible AI usage (Steele, 2023). Establishing holistic institutional frameworks, strategic research agendas, and cross-curriculum AI literacy initiatives ensures that both teachers and learners are equipped to navigate the AI generation gap effectively and ethically (Chan, 2023; Chiu, 2023; Southworth et al., 2023).

### **Current Research and Applications of Language Models in Education**

To ground speculative possibilities in empirical evidence, recent research published between 2018 and 2023 examines how Large Language Models (LLMs) function within real-world learning environments. Investigating the learner's perspective, studies highlight ChatGPT's role as an interactive "more knowledgeable other" that fundamentally reshapes student help-seeking behavior, information retrieval, and self-directed study (Adams et al., 2023; Stojanov, 2023). Empirical trials demonstrate that prompt-engineered interactions in flipped classrooms, virtual physics tutoring, and collaborative discourse platforms foster higher-order cognitive skills, active knowledge creation, and problem-solving capacities (Ding et al., 2023; Essel et al., 2023; Lee et al., 2023; Wang et al., 2023).

Beyond general cognitive scaffolding, empirical investigations evaluate student acceptance, motivation, and discipline-specific applications across higher education environments. Utilizing extended Technology Acceptance Models (TAM) and Expectancy Value Theory (EVT), studies reveal that student adoption is heavily driven by intrinsic motivation, perceived efficacy, and generational readiness, with Gen Z learners showing high enthusiasm for AI integration (Chan & Hu, 2023; Chan & Lee, 2023; Chan & Zhou, 2023; Lai et al., 2023). Furthermore, field studies in engineering

education and second language (L2) writing confirm that while AI-generated feedback and conversational practice enhance task completion and lessen performance anxiety, students remain hyper-aware of ethical implications, academic integrity concerns, and detection probabilities (Bernabei et al., 2023; Dakakni & Safa, 2023; Escalante et al., 2023; Farhi et al., 2023).

From the teachers' perspective, recent empirical works explore how educators adopt and integrate generative AI through the lens of institutional technology acceptance and pedagogical belief systems, spanning constructivist and transmissive paradigms. Systematic literature reviews and case studies indicate that instructors utilize AI tools primarily for workflow optimization, including automated feedback generation, syllabus structuring, and exercise development (Ali et al., 2023; Labadze et al., 2023; Tlili et al., 2023). In writing-intensive disciplines, empirical evaluations demonstrate that combining AI-generated formative feedback with traditional instructor evaluation significantly improves feedback immediacy without diminishing teacher agency, provided that educators maintain active oversight over the assessment process (Barrett & Pack, 2023; Escalante et al., 2023; Steele, 2023).

Finally, addressing the "unknown unknowns," the current body of literature establishes a crucial epistemological buffer by identifying persistent research gaps and mapping systemic risks. Systematic scoping reviews emphasize that despite rapid adoption, significant uncertainties persist regarding long-term cognitive impacts, equity divides, and assessment validity (Crompton & Burke, 2023; Yan et al., 2023). Scholars overwhelmingly conclude that while ChatGPT poses threats to traditional academic integrity and epistemic evaluation, AI must strictly function as an assistive scaffolding tool rather than a replacement technology for human educators and critical discourse (Benuyenah, 2023; Bin-Nashwan et al., 2023; Chiu, 2023; van Dis et al., 2023).

## **Key Challenges and Risks Related to the Application of Large Language Models in Education**

### **1. Copyright Issues**

The deployment of Large Language Models (LLMs) in educational settings presents unresolved legal and intellectual property challenges regarding training corpora and output generation. Because models like ChatGPT are trained on massive web-scale datasets containing copyrighted books, academic journals, and proprietary digital content, their integration into educational workflows creates significant exposure to copyright infringement claims (van Dis et al., 2023; Yan et al., 2023). When students or educators use these models to generate study guides, summaries, or scholarly drafts, the risk of inadvertently reproducing copyrighted text without appropriate authorization or attribution threatens both institutional compliance and academic publishing standards (Liebrenz et al., 2023; Nam & Bai, 2023).

To mitigate these intellectual property risks, educational institutions must establish clear governance frameworks regarding data permissions and open-source compliance. This involves advocating for transparent licensing terms from AI vendors, utilizing open-access training corpora for custom educational models, and embedding explicit fair-use guidelines into institutional policies (Bin-Nashwan et al., 2023; Dwivedi et al., 2023). Furthermore, institutions must educate both faculty and students on proper attribution protocols when integrating model-generated content into research and coursework, ensuring that technological adoption respects existing copyright laws while supporting creative scholarly engagement (Chan, 2023).

### **2. Bias and Fairness**

Algorithmic bias represents one of the most critical socio-technical risks when integrating generative AI into diverse educational environments. Because LLMs reflect the cultural, linguistic, and historical biases embedded within their training data, their outputs often reproduce and amplify societal inequalities, eurocentric worldviews, and demographic stereotypes (Dakakni & Safa, 2023; Farhi et al., 2023). In educational

settings, this can lead to discriminatory content generation, unequal performance across different student demographics, and the systemic marginalization of non-dominant cultural perspectives (Stahl & Eke, 2023; Yan et al., 2023).

Addressing issues of bias and fairness requires a multi-layered mitigation strategy combining technical auditing and human oversight. AI developers and educational institutions must prioritize training models on diverse, representative datasets while implementing rigorous bias-auditing protocols prior to classroom deployment (Ali et al., 2023; Dwivedi et al., 2023). On a pedagogical level, instructors must encourage students to critically interrogate model outputs for underlying cultural or ideological biases, transforming algorithmic limitations into active learning opportunities that foster critical digital literacy and socio-ethical awareness (Chiu, 2023; Steele, 2023).

### **3. Learner Over-Reliance**

The seamless availability of conversational AI poses a fundamental threat to student cognitive development by encouraging excessive reliance and passive learning habits. When students utilize ChatGPT as a shortcut to bypass rigorous analytical tasks, writing exercises, or problem-solving processes, they risk cognitive offloading that degrades critical thinking, original reasoning, and deep conceptual understanding (Adams et al., 2023; Essel et al., 2023). Over time, unchecked reliance on conversational agents can erode student confidence in their own independent intellect, turning proactive learners into passive consumers of machine-generated answers (Chan & Hu, 2023; Stojanov, 2023).

Mitigating learner over-reliance requires a fundamental shift in pedagogical design from product-oriented to process-oriented learning. Educators should structure assignments where LLMs are restricted to initial brainstorming, hypothesis generation, or outline drafting, requiring students to manually verify, critique, and expand upon model outputs (Ding et al., 2023; Lee et al., 2023). By embedding explicit

reflection phases and oral defense components into course design, institutions can ensure that AI functions as a cognitive scaffold that elevates intellectual inquiry rather than a substitute for authentic human effort (Chan & Zhou, 2023; Steele, 2023).

#### **4. Teacher Over-Reliance**

While generative AI offers workflow efficiency for educators, an over-reliance on LLMs for instructional tasks threatens to compromise pedagogical quality and individual teacher agency. Instructors who depend excessively on automated systems for lesson planning, exercise generation, and essay grading risk homogenizing their teaching practices and losing the empathetic, nuanced connection that defines effective human instruction (Ali et al., 2023; Barrett & Pack, 2023). Furthermore, automated assessment tools can propagate standardized evaluation biases, misinterpreting creative or non-traditional student responses (Benuyenah, 2023; Tlili et al., 2023).

To counteract these risks, educational institutions must position AI strictly as a complementary tool that augments, rather than replaces, professional teacher judgment. Ongoing professional development programs should emphasize the importance of contextual pedagogical knowledge, training educators to critically evaluate and customize AI-generated teaching materials (Labadze et al., 2023; Southworth et al., 2023). Maintaining human-in-the-loop requirements for all high-stakes assessments ensures that empathetic feedback, nuanced grading, and personal mentorship remain the cornerstone of the educational process (Escalante et al., 2023; Yan et al., 2023).

#### **5. Lack of Understanding and Expertise**

A major structural barrier to effective AI integration is the widespread lack of technical expertise and institutional readiness among educators and administrators. Many teachers feel unprepared to navigate prompt engineering, detect AI misuse, or integrate generative tools effectively into their domain-specific curricula (Chan & Lee,

2023; Crompton & Burke, 2023). This expertise gap fosters an environment of institutional anxiety, leading either to reactive bans on technology or to uncritical, unsafe classroom adoption (Ali et al., 2023; Bin-Nashwan et al., 2023).

Overcoming this challenge requires targeted, demand-oriented training initiatives and the development of comprehensive institutional policies. Higher education systems must invest in continuous professional development and establish interdisciplinary communities of practice where faculty can share effective prompt strategies and pedagogical frameworks (Chan, 2023; Southworth et al., 2023). By equipping educators with foundational AI literacy and practical competency guidelines, institutions can bridge the generational knowledge gap and foster a culture of informed, responsible innovation (Chiu, 2023; Steele, 2023).

## **6. Detection Difficulty**

The high linguistic fluency of model-generated text makes it increasingly difficult to distinguish machine-written content from authentic student work, creating an existential threat to traditional modes of academic integrity. Conventional plagiarism detection tools are largely ineffective against LLM outputs, while specialized AI detectors frequently suffer from high false-positive rates that unfairly penalize non-native English speakers (Bernabei et al., 2023; Farhi et al., 2023). This technological asymmetry leaves educators struggling to enforce academic honesty policies through traditional surveillance methods (Benuyenah, 2023; Bin-Nashwan et al., 2023).

Rather than relying on unreliable technical detection tools, institutions must redesign assessment methodologies to build resilient integrity frameworks. This includes adopting authentic assessment strategies—such as in-class presentations, viva voce examinations, collaborative group projects, and reflective portfolios—that evaluate real-time critical thinking (Chan & Hu, 2023; Yan et al., 2023). Simultaneously, exploring cryptographic watermarking and clear institutional policies on acceptable AI use helps establish a transparent environment where academic honesty is maintained

through pedagogical design rather than adversarial detection (Chiu, 2023; Dwivedi et al., 2023).

## **7. Sustainable Usage**

The widespread scaling of Large Language Models introduces significant environmental and economic sustainability challenges for the educational sector. Training and running massive transformer models requires immense computational power and cooling infrastructure, contributing substantially to global carbon emissions and energy consumption (Gill & Kaur, 2023; Gill et al., 2023). Furthermore, reliance on costly proprietary AI infrastructures places severe financial strains on underfunded schools and institutions in developing regions, threatening to exacerbate the global educational divide (Dakakni & Safa, 2023; Dwivedi et al., 2023).

Addressing sustainability requires a dual focus on technological efficiency and equitable governance frameworks. Educational institutions and researchers should advocate for lightweight, open-source, and domain-distilled language models that require a fraction of the computational resources of massive commercial systems (Gill et al., 2023; Yan et al., 2023). In addition, institutional procurement policies should prioritize cloud providers powered by renewable energy, while international educational frameworks work to democratize compute access so that advanced learning technologies remain environmentally responsible and globally accessible (Chan, 2023; Chiu, 2023).

## **8. Real vs. Model-Generated Knowledge**

The tendency of LLMs to "hallucinate"—generating factually incorrect statements, false citations, or misleading arguments with high conversational confidence—poses a severe threat to epistemological integrity in education. Uncritical students often accept model outputs as authoritative truth, leading to the assimilation and spread of subtle misinformation across academic assignments (Benuyenah, 2023; van Dis et al., 2023). This difficulty in separating human-verified facts from machine-

generated plausibility compromises foundational learning, particularly in fields requiring strict empirical accuracy such as STEM and medicine (Liebrenz et al., 2023; Nam & Bai, 2023).

Combating the risks of model hallucinations demands explicit instructional focus on critical evaluation, source verification, and prompt engineering skills. Teachers must train students to treat LLM outputs as unverified primary drafts that necessitate rigorous cross-checking against peer-reviewed literature and authoritative databases (Ding et al., 2023; Stojanov, 2023; Wang et al., 2023). Integrating fact-checking exercises into standard curricula ensures that students develop the healthy skepticism and analytical vigilance required to navigate an AI-saturated information ecosystem (Steele, 2023; Yan et al., 2023).

## **9. Lack of Adaptability**

Despite their vast training datasets, standard LLMs exhibit a fundamental lack of real-time situational adaptability due to static knowledge cutoff dates and an inability to perceive immediate classroom dynamics. Standard models operate purely on probabilistic text patterns without true contextual awareness, emotional intelligence, or real-time understanding of individual student learning trajectories (Crompton & Burke, 2023; Lai et al., 2023). Consequently, when students face complex conceptual hurdles or nuanced personal difficulties, static model responses can be contextually tone-deaf, unhelpful, or pedagogically inappropriate (Lee et al., 2023; Tlili et al., 2023).

Overcoming these adaptability limitations requires combining generative models with multimodal learning platforms and adaptive hybrid teaching frameworks. Educational software developers can enhance model responsiveness by integrating real-time retrieval-augmented generation (RAG) systems and multimodal interfaces that incorporate visual, auditory, and contextual data (Gill et al., 2023; Wang et al., 2023). Most importantly, human instructors must remain actively involved to provide

the necessary emotional intelligence, adaptive scaffolding, and real-time intervention that automated software inherently lacks (Barrett & Pack, 2023; Yan et al., 2023).

### **Further Issues Related to User Interfaces and Fair Access**

Elevating the educational dialogue from micro-pedagogical classroom dynamics to macro-level socio-technical and global equity concerns begins with Human-Computer Interaction (HCI) and appropriate user interface design. Interface mechanics heavily dictate how students engage with Large Language Models (LLMs); young primary-school learners require intuitive, gamified environments that hide raw machine artifacts behind guided scaffolding to prevent cognitive overload and uncritical acceptance (Crompton & Burke, 2023; Tlili et al., 2023). Conversely, older secondary and higher education students benefit from transparent interfaces that explicitly expose prompt mechanics, confidence scores, and source parameters (Southworth et al., 2023; Steele, 2023). By tailoring age-appropriate UI/UX frameworks, educational platforms can actively foster critical evaluation, prompt engineering literacy, and technical self-awareness rather than encouraging passive consumption (Chan, 2023; Chiu, 2023).

Beyond interface design, a critical socio-technical challenge facing global adoption is the systemic linguistic bias inherent in modern LLM training corpora. Because mainstream foundational models are trained predominantly on English-centric web data, non-English speaking students and second-language (L2) learners frequently experience lower translation quality, subtle cultural misrepresentations, and higher hallucination rates (Dakakni & Safa, 2023; Farhi et al., 2023). This linguistic hegemony threatens to marginalize local knowledge systems and non-Western educational paradigms, forcing global students into standardized Anglo-centric communication modes (Ali et al., 2023; Yan et al., 2023). Overcoming this divide requires concerted efforts to develop localized, multilingual models and inclusive

training datasets that uphold regional cultural nuance and linguistic diversity (Dwivedi et al., 2023).

Finally, the equitable distribution of generative AI technology is constrained by deep economic barriers to computational infrastructure, subscription costs, and high-speed digital connectivity. While well-funded institutions can easily afford enterprise AI integrations and high-compute hardware, under-resourced schools and developing nations face severe structural exclusion, threatening to widen the global educational divide (Bin-Nashwan et al., 2023; Gill et al., 2023). To prevent generative technologies from exacerbating socio-economic stratification, institutional and international policy recommendations must align with UNESCO's *Education 2030 Agenda* by prioritizing open-access AI tools, public compute resources, and equitable digital infrastructure (Chan, 2023; Chiu, 2023). Proactive governance and cross-border partnerships are imperative to ensure that AI serves as a public good for global educational empowerment (Chan & Hu, 2023; Dwivedi et al., 2023).

## Conclusion

The integration of Large Language Models (LLMs) such as ChatGPT into educational environments marks a permanent, transformative shift that defies simple binary categorization. Synthesizing the broader discourse yields a position of "cautious optimism": while generative AI holds extraordinary potential to personalize learning, streamline instructional workflows, and serve as an interactive cognitive scaffold, it simultaneously introduces profound epistemic, ethical, and operational challenges. Threats to academic integrity, algorithmic bias amplification, student cognitive over-reliance, and data privacy risks cannot be dismissed as temporary technical glitches. Rather, they represent structural vulnerabilities that require a fundamental recalibration of how educational systems assess knowledge, foster critical thinking, and design learning interactions.

Crucially, these significant pedagogical and socio-technical risks are not insurmountable barriers, but manageable parameters that can be navigated through proactive governance and continuous human oversight. By implementing structured problem-mitigation strategies—ranging from process-oriented assessment redesign and prompt engineering instruction to bias auditing and open-access licensing—institutions can mitigate risks without suppressing technical innovation. Preserving a strict "human-in-the-loop" model ensures that LLMs remain assistive tools designed to elevate student agency and teacher productivity, rather than autonomous replacements for empathetic instruction and authentic scholarly inquiry.

Ultimately, the final verdict on generative AI in education will not be determined by the speed of algorithmic advancement, but by the intentionality of institutional policy and pedagogical vision. To fulfill the promise of AI as a catalyst for equitable educational empowerment, higher education systems must champion comprehensive AI literacy, bridge global digital divides, and align adoption strategies with broader human-centered learning goals. By balancing visionary opportunity with rigorous risk mitigation, educators can guide learners from passive AI consumers into critical, ethically grounded navigators of an AI-driven world.

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CJN: Conceptualization, Methodology, Investigation, Writing – Original Draft, Visualization. SUR: Formal Analysis, Writing – Review & Editing.

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### **Conflict of Interest Statement**

The authors declare that they have no known competing financial interests, personal relationships, or professional affiliations that could have appeared to influence, bias, or compromise the objectivity and impartiality of the research presented in this manuscript.

### **Declaration of Generative AI and AI-Assisted Technologies**

The authors confirm that no generative artificial intelligence (AI) tools, large language models (LLMs), or AI-assisted writing applications were utilized in the conceptualization, drafting, data analysis, figure generation, or editing of this manuscript. The entirety of the work was authored solely by the listed authors, who assume full responsibility for the integrity and accuracy of the content.

### **Additional Information**

Not applicable. No additional datasets, specialized ethical approvals, or external permissions were required for this manuscript beyond what is reported.

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