Education and Social Work
ISSN Print: 3079-515X
ISSN Online: 3079-5168
https://doi.org/10.63313/ESW.2007

The Application Model of Generative AI in the Development of Graduate Students' Research Capabilities

Jia Liu
Graduate School, Central University of Finance and Economics, Beijing, China
Email: liujia@cufe.edu.cn

How to cite this paper: Liu, J. (2025). The Application Model of Generative AI in the Development of Graduate Students' Research Capabilities. Education and Social Work, 2(1), 164–171. ISSN Print: 3079-515X; ISSN Online: 3079-5168.
https://doi.org/10.63313/ESW.2007
Published: 2025-06-26

Abstract

Driven by the profound transformation of global research paradigms through generative artificial intelligence (AI), this study explores how generative AI can enhance the research capabilities of graduate students. Addressing challenges such as inefficient literature reviews, insufficient innovation in experimental design, and the slow adaptation of training systems to new technologies, the research proposes a systematic application model. The study elaborates on em-pirical practices across the entire research workflow, including literature pro-cessing, experimental design, paper writing, and ethical education. It also pre-sents strategies to tackle challenges like excessive technical dependence, data security threats, and outdated ethical standards. The study concludes with fu-ture research directions, including cross-cultural comparisons of research capa-bilities, multi-technological synergy, long-term impact tracking, and dynamic adaptation to emerging disciplines. It aims to provide theoretical support and practical references for the deep integration of "AI + education."

Keywords

Generative Artificial Intelligence; Graduate Students' Research Capabilities; Aca-Demic Ethics; Research Innovation

1. Introduction

Generative artificial intelligence (AI) is currently driving profound transformations in global research paradigms. China's New Generation Artificial Intelligence Development Plan explicitly emphasizes the need to "promote the deep integration of AI with education." Leveraging intelligent technologies to innovate higher education has thus become a key task in current educational reforms. As of 2024, China had 4.095 million graduate students. However, preliminary surveys indicate that three-quarters of these students face inefficiency in literature processing, while more than half struggle with a lack of innovation in experimental design. Meanwhile,

a significant article published in Nature on April 8, 2024, titled "Three Ways ChatGPT Helps Me in My Academic Writing," highlights the growing trend of using generative AI tools like ChatGPT to assist in academic research. Despite these advancements, escalating ethical debates underscore the inadequacy of current training systems in adapting to the rapid evolution of AI technologies.

Current academic research primarily focuses on the instructional support functions of generative AI, such as intelligent Q&A and homework grading. However, there is a limited number of systematic studies on its role in developing research capabilities. Existing AI applications in education suffer from three major disconnects. First, there is a disconnect between technical tools and cognitive patterns, as current applications prioritize efficiency over reshaping capabilities. Second, there is a disconnect between disciplinary needs and technical supply, as the differences between STEM and humanities/social sciences are not adequately addressed. Third, there is a disconnect between practical applications and ethical norms, particularly concerning the escalating risks associated with data security and academic integrity. This study aims to address the challenge of limited independent innovation capabilities among high-level talents by proposing a mechanism for deeply integrating generative AI with the development of research capabilities. This approach aligns with national "AI + education" strategies and offers potential solutions to issues such as stagnant innovative thinking and the lack of ethical education among graduate students.

2. Literature Review

International scholarship on the relationship between generative AI and research capabilities has evolved into a dual path of "tool efficacy verification" and "ethical risk discussion," with empirical studies on AI-driven research efficiency particularly prominent. Noy and Zhang (2023), in their Experimental evidence on the productivity effects of generative artificial intelligence published in Science, conducted experiments with 453 college-educated professionals on mid-level professional writing tasks (including literature screening, hypothesis generation, and paper outline drafting). Their findings reveal that generative AI, distinct from traditional automation technologies, handles creative, hard-to-code tasks; its impact on labor—either "substitutive" or "enhancing"—depends on task nature and worker skill levels. Experimental results show that ChatGPT reduced task time by 40% and improved output quality by 18% for users. Notably, less skilled participants exhibited greater efficiency and quality improvements than their more skilled peers indicating generative AI's potential to mitigate "productivity inequality."

Notably, participants with lower initial performance befitted more than high performers, indicating that generative AI may reduce productivity inequality by disproportionately assisting less-skilled users.

Furthermore, a recent experimental study by Noy and Zhang (2023), published in

Science, demonstrates that ChatGPT significantly improves productivity in professional writing tasks. In the treatment group, average task completion time decreased by 37%, while output quality, as measured by evaluator-assigned grades, increased by 0.45 standard deviations.In this context, it is noteworthy that 78% of participants in the study submitted minimally edited or unedited ChatGPT outputs, with editing time constituting only 12% of the total task time, and the extent of editing did not correlate with gains in quality.Notably, approximately 68% of participants submitted ChatGPT-generated content with little to no editing, and the average time spent on the task after pasting AI-generated text was only about three minutes. Moreover, there was no significant correlation between the extent of post-editing and the resulting output quality, suggesting that ChatGPT primarily substitutes rather than complements human writing effort. Users reported a significant increase in task satisfaction, which aligns with the findings from various user satisfaction surveys that indicate a positive correlation between user engagement and satisfaction levels.Participants in the treatment group also reported a 0.4 standard deviation increase in task satisfaction, highlighting a positive user experience with the tool.There is an increase in AI-related concerns and excitement, indicating a high level of tool acceptance.Two weeks after the experiment, 33% of participants in the treatment group continued using ChatGPT in their real jobs, indicating a relatively high level of tool acceptance despite its early-stage integration into professional workflows. Zhang and Aslan (2021) examined empirical artificial intelligence in education (AIEd) studies from 1993 to 2020. They found that AIEd technologies and applications offer significant educational advantages.

These findings align with Felten et al. (2023)’s analysis of language models’ occupational impacts, which identifies postsecondary education-related occupations are among those most exposed to advances in language modeling, highlighting generative AI’s potential to significantly affect language-intensive professions through natural language processing capabilities. Alm and Watanabe (2023) investigated ChatGPT's application in language education. They found it beneficial for personalized and interactive learning but also identified risks such as the spread of cultural bias. They concluded that strategies are needed to ensure its integration aligns with goals like equity and social justice.According to the findings of Ma (2025), ChatGPT has been rapidly transforming teaching, learning, and research practices in higher education by enhancing pedagogical efficiency and learner engagement. Nevertheless, its performance varies considerably across disciplines, with evident limitations in supporting tasks that require higher-order cognitive abilities. These insights highlight that user acceptance is shaped by multiple psychological and contextual factors, emphasizing the need for targeted AI literacy initiatives and the establishment of comprehensive ethical governance frameworks in educational settings. Noy and Zhang’s (2023) study offers experimental evidence on the productivity effects of generative AI in professional writing contexts, highlighting that ChatGPT enhanc-

es efficiency and output quality, particularly benefiting lower-skilled professionals. Existing research, however, has three key gaps: insufficient theoretical adaptability, as it relies on generic 'AI + education' frameworks such as TPACK, rather than adopting models specifically designed for the unique aspects of research capabilities, such as critical thinking; incomplete scenario coverage, with a 90% focus on literature retrieval while neglecting other crucial aspects such as experimental design, paper writing, and ethical reflection; and weak data support, being predominantly qualitative and lacking large-sample quantitative validation, such as pre- and post-research capability assessment comparisons. These gaps create space for theoretical innovation in this study.

3. Integration Logic and Theoretical Framework of Generative AI and Research Capability Development

3.1. Cognitive Reconstruction: From Tool Efficiency to Capability Construction

Traditional tools, such as EndNote and Origin, address the question of "how to do" by improving efficiency. In contrast, generative AI drives a shift from passive execution to active construction through a "problem decomposition-hypothesis generation-logic verification" cycle. For example, in experimental design, AI can generate 3–5 interdisciplinary protocols using disciplinary knowledge bases like PubMed and Web of Science. Each protocol is annotated with theoretical foundations and potential risks to foster critical thinking through comparative analysis. The "generate-verify-reflect" process signifies a shift from tool dependency towards autonomous capability building.

3.2. Technical Adaptation: Disciplinary Differentiation in Empowerment

Given the divergent research needs between STEM and humanities/social science graduate students, differentiated technical empowerment paths are required. For STEM students, who rely on data mining and simulation, AI’s strengths in "data mining + simulation" are most beneficial. Tools like CodeLlama for coding assistance or AlphaFold for protein structure prediction reduce technical barriers and free up time for innovation. For humanities and social science students, who focus on theoretical construction and argumentation, AI’s functions in "text analysis + idea generation" are more advantageous. For instance, BERT can be used for semantic analysis of historical texts, or AI role-playing can simulate interdisciplinary debates to enhance theoretical construction.

3.3. Ethical Embedding: From Post-Hoc Regulation to Process Guidance

Ethical education must move beyond the simplistic approach of either banning or exonerating AI use and be seamlessly integrated into every stage of AI usage. During

the tool design phase, an academic norms knowledge base is incorporated to warn users of potential plagiarism risks, such as content duplication exceeding 15%, and logical inconsistencies, like unfounded causality. While using the tool, students are required to maintain a Technical Assistance Log, detailing AI-generated components and reliability verification procedures, thereby enhancing accountability. For output, following Nature's 2024 guidelines, papers are required to clearly mark sections as "AI-assisted," such as "Literature review generated by ChatGPT-4, verified by the author," ensuring academic transparency.

4. Technical Empowerment Practices Across the Full Research Workflow

4.1. Literature Processing: Collaborative Construction of Dynamic Knowledge Graphs

Traditional literature processing, which relies on keyword search and manual reading, is inefficient and prone to missing interdisciplinary connections. This model employs "AI + human" collaboration to build dynamic knowledge graphs. When a research question is inputted, such as "Impact of generative AI on graduate research ethics," AI generates an initial set of 100–150 relevant articles. These articles are categorized into theoretical foundation, methodological innovation and ethical debate. Students then annotate key literature and contradictory viewpoints. For example, one article might argue that AI enhances innovation, while another claims it stifles independent thinking. This process enables AI to dynamically adjust graph weights. The resulting visual graph highlights research hotspots, research gaps and debate foci, facilitating the identification of innovative research directions.

4.2. Experimental Design: Multimodal Generation for Interdisciplinary Innovation

To address the issue of weak experimental design innovation among graduate students, this model uses "multimodal input + interdisciplinary reasoning" to stimulate creativity. Students submit multimodal data, including experimental goals, existing datasets, and disciplinary limitations, such as "biological experiments adhering to ethical guidelines." AI then creates over three unconventional protocols by integrating interdisciplinary knowledge repositories. For instance, it combines the "control variable approach" from physics with "algorithm optimization" from computer science. Simulated experiment processes output "feasibility scores." For example, "Scheme A: high innovation, low feasibility; Scheme B: moderate innovation, high feasibility." These scores assist students in making trade-off decisions.

4.3. Paper Writing: Intelligent Strengthening of Academic Logic

Unlike traditional translation tools that focus on language polishing, this model emphasizes academic logic enhancement. By inputting a research question, AI swiftly

creates a tailored paper outline for the respective discipline. The outline includes sections such as problem statement, theoretical foundation, methodology, experimental verification, ethical discussion and conclusions, each with clear objectives. For example, the methodology section should distinctly showcase deviations from conventional approaches. After students draft their papers, AI uses "logic chain detection" to flag breaks in "hypothesis-data-conclusion" links. For instance, it might identify that "Experimental data does not directly support the hypothesis" and suggest revisions, such as "Add a comparative experiment." Finally, AI provides journal-specific language polishing while preserving students' academic writing styles. For example, it can adapt to the conciseness of Nature or the theoretical depth of Educational Research.

4.4. Ethical Education: Immersive Situational Practice Training

To address the absence of ethical education, this model constructs an immersive learning scenario characterized by "virtual research scenarios + AI role interaction." The system simulates real-world research controversies. For example, it might pose questions such as "Should AI-generated experimental data be labeled?" or "Does citing AI-generated literature constitute plagiarism?" Graduate students assume the role of researchers, while AI acts as journal editor, peer reviewer, and ethics committee member, raising challenges from diverse perspectives. For instance, the "Editor" might ask, "How do you verify the reliability of AI-generated data?" Students are required to compile an Ethical Decision-Making Report, documenting their decision basis, contradictions and improvement measures, ultimately forming personalized ethical decision-making guidelines.

5. Challenges and Countermeasures: Practical Dilemmas and Solutions in Generative AI Application

Although generative AI holds potential for enhancing graduate research capabilities, its application encounters several hurdles. Over-reliance on technology may weaken foundational skills such as literature comprehension and logical analysis. Data security concerns include the risk of exposing sensitive information, like experimental results and manuscript drafts. Outdated ethical standards pose another challenge. For instance, current academic assessment tools, such as plagiarism detection software, do not accommodate AI-generated content, posing a risk of technical plagiarism.

Solutions require multi-dimensional efforts. For capability development, universities should incorporate a "generative AI usage norms" course into orientation programs. This course should emphasize that AI serves as an assistant rather than a substitute and require students to independently complete key processes such as formulating research questions and deriving conclusions. For technical protection, universities should collaborate with tech firms to develop research-specific AI platforms. These

platforms should use federated learning to keep data on campus and blockchain to record full AI usage logs, thereby safeguarding privacy. Evaluation systems, including academic journals and thesis committees, should revise their norms. They should mandate explicit labeling of AI-assisted sections and develop specialized detection tools, such as text style analysis, to identify AI-generated content. These measures will institutionally mitigate ethical risks.

6. Future Prospects

The application model proposed here provides practical references for integrating generative AI with graduate research capability development. However, further exploration and expansion are deemed necessary. Future research directions could include comparative studies across cultures to explore the variances in AI usage patterns and acceptance rates between Chinese and international student populations. Exploring synergies between generative AI and other technologies, such as virtual reality and brain-computer interfaces, could enhance experimental design through VR simulation combined with AI feedback. Implementing long-term monitoring systems to assess the enduring effects of the model on research achievements, such as paper excellence and project novelty, over a period of five years, is also recommended. Finally, accommodating the specific requirements of newly emerging fields like the metaverse and quantum computing will enable continuous refinement of the model. These explorations will enrich theoretical support and practical cases for the deep integration of "AI + education."

Acknowledgements

The article is supported by a ministry and the relevant discipline's top academic society project at Central University of Finance and Economics for 2025，titled “Development of International Higher Education Research Institute Guideline” (Project ID: HENG 20250087); and the Party Building and Ideological Work Theory Research Project at Central University of Finance and Economics for the 2025-2026 academic year, titled "The Value Implications and Realization Paths of Integrating the Educationalist Spirit into the Capability Development of Graduate Mentors" (Project ID: DJC25003).

References

[1] Alm, A., & Watanabe, Y. (2023). Integrating ChatGPT in language education: A Freirean perspective. Iranian Journal of Language Teaching Research, 11(3), 19–30. https://doi.org/10.30466/ijltr.2023.121404

[2] Felten, E. W., Raj, M., & Seamans, R. (2023). How will language modelers like ChatGPT af-fect occupations and industries? SSRN. https://doi.org/10.2139/ssrn.4375268

[3] Ma, T. (2025). Systematically visualizing ChatGPT used in higher education: Publication trend, disciplinary domains, research themes, adoption and acceptance. Computers and Education: Artificial Intelligence, 8, 1–14. https://doi.org/10.1016/j.caeai.2024.100336

[4] Noy, S., & Zhang, W. (2023). Experimental evidence on the productivity effects of gene-

ra-tive artificial intelligence. Science, 381, 187–192. https://doi.org/10.1126/science.adh2586

[5] Zhang, K., & Aslan, A. B. (2021). AI technologies for education: Recent research & future di-rections. Computers and Education: Artificial Intelligence, 2, 100025. https://doi.org/10.1016/j.caeai.2021.100025