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Multidimensional Impact of Digital Tools on PhD Academic Seekers Research Work in Modern Higher Education

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Abstract. The purpose of paper is to analyze the role of digital tools in PhD candidates' research and identify the opportunities and risks of generative artificial intelligence in higher education. Methodology combines systemic analysis of academic practices, qualitative analysis of digital platforms, and comparison of traditional and digital research workflows. SWOT analysis is used to systematize strengths, weaknesses, opportunities, and threats. Results show that digital tools perform three interconnected functions: cognitive-analytical, organizational-managerial, and communicative-reputational. Learning management systems, bibliographic managers, and analytical software help organize research, review literature and data, support academic communication, and disseminate findings. Generative AI expands opportunities for synthesizing sources, automating tasks, and improving academic language, but also creates risks of mosaic plagiarism, fabricated references, biased outputs, and breaches of data confidentiality. The study also identifies technological determinism as a concern: research methods may be chosen to fit software capabilities rather than scientific needs. Originality lies in systematizing the multidimensional functions of digital tools in doctoral research and examining their potential and ethical risks through SWOT analysis. The study argues that AI should act as a research "co-pilot," while intellectual responsibility and authorship of scientific conclusions remain with the researcher. Practical significance is that universities can use the findings to develop guidance for responsible use of digital platforms and AI, introduce digital literacy and academic integrity modules, encourage transparent disclosure of AI use, and improve procedures for verifying PhD candidates' independent contributions.
Key words: artificial intelligence, digital literacy, academic integrity, research methodology, digital scholarship, AI ethics.

Багатовимірний вплив цифрових інструментів на наукові дослідження здобувачів доктора філософії у сучасній вищій освіті

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Анотація. Метою дослідження є комплексний аналіз ролі цифрових інструментів у науковій діяльності здобувачів ступеня доктора філософії та визначення можливості й ризиків застосування генеративного штучного інтелекту у вищій освіті. Методологія ґрунтується на системному аналізі академічних практик, якісному аналізі цифрових платформ і порівнянні традиційних та цифрових дослідницьких процесів. Для систематизації переваг, обмежень, можливостей і загроз застосовано SWOT-аналіз. Результати засвідчили, що цифрові засоби виконують три взаємопов'язані функції: когнітивно-аналітичну, організаційно-управлінську та комунікативно-репутаційну. Освітні платформи, бібліографічні менеджери й аналітичні пакети допомагають упорядковувати дослідницьку роботу, опрацьовувати літературу й дані, підтримувати академічну комунікацію та поширювати наукові результати. Генеративний ШІ розширює можливості синтезу джерел, автоматизації завдань і мовного редагування, проте створює ризики мозаїчного плагіату, вигаданих посилань, упереджених результатів і порушення конфіденційності. Виявлено також небезпеку технологічного детермінізму, коли методи дослідження обирають відповідно до можливостей програмного забезпечення, а не наукової доцільності. Оригінальність роботи полягає в систематизації багатовимірних функцій цифрових інструментів у докторському дослідженні та комплексному аналізі їхнього потенціалу й етичних ризиків на основі SWOT-аналізу. Обґрунтовано, що ШІ має бути «ко-пілотом», а інтелектуальна відповідальність і авторство наукових висновків повинні залишатися за дослідником. Практичне значення результатів полягає в можливості їх використання університетами для розроблення рекомендацій щодо відповідального застосування цифрових платформ і ШІ,

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упровадження модулів цифрової грамотності та академічної доброчесності, прозорого декларування використання ШІ й удосконалення перевірки самостійного внеску здобувачів PhD.
Ключові слова: штучний інтелект, цифрова грамотність, академічна доброчесність, методологія дослідження, цифрова наука, етика ШІ.

I Introduction

In the context of the global digitalization of higher education, the activities of PhD academic seekers have undergone qualitative changes. "Digital means" are no longer merely auxiliary tools; they have become the foundation of the research environment (Haleem et al., 2022). The modern university requires a young scholar to possess not only deep subject knowledge but also a high level of digital competence. The relevance of this topic stems from the need to systematize the functions of IT solutions that accompany a doctoral student through all stages: from initial literature reviews to the final dissertation defense and the promotion of results in international databases (Henderson et al., 2021).

In the context of the global digitalization of higher education, the activities of PhD academic seekers have undergone qualitative changes. "Digital means" are no longer merely auxiliary tools; they have become the foundation of the research environment (Haleem et al., 2022). The emergence of Large Language Models (LLMs) and specialized AI research tools has created a paradigm shift. For an academic seeker, the pressure to produce high-impact research within limited timeframes makes AI an attractive ally (Henderson et al., 2021). However, as universities struggle to update their honor codes, the boundary between "AI-assisted" and "AI-generated" work becomes increasingly blurred.

To address this gap, this study aims to comprehensively analyze the multidimensional role of digital tools in doctoral research, explicitly mapping out the catalyst opportunities and systemic threats posed by generative AI within modern higher education.

II Materials and Methods

This study is based on a systemic analysis of academic practices in modern universities. Qualitative analysis methods were applied to digital platforms (LMS, bibliographic managers, analytical packages), alongside a comparative approach to evaluate the effectiveness of traditional versus digital scientific workflows (Creswell & Creswell, 2022).

This study employs a systematic SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) based on current academic policies and qualitative analysis of digital platforms (LMS, bibliographic managers, analytical packages) used in modern universities (Fig. 1) (Creswell & Creswell, 2022).

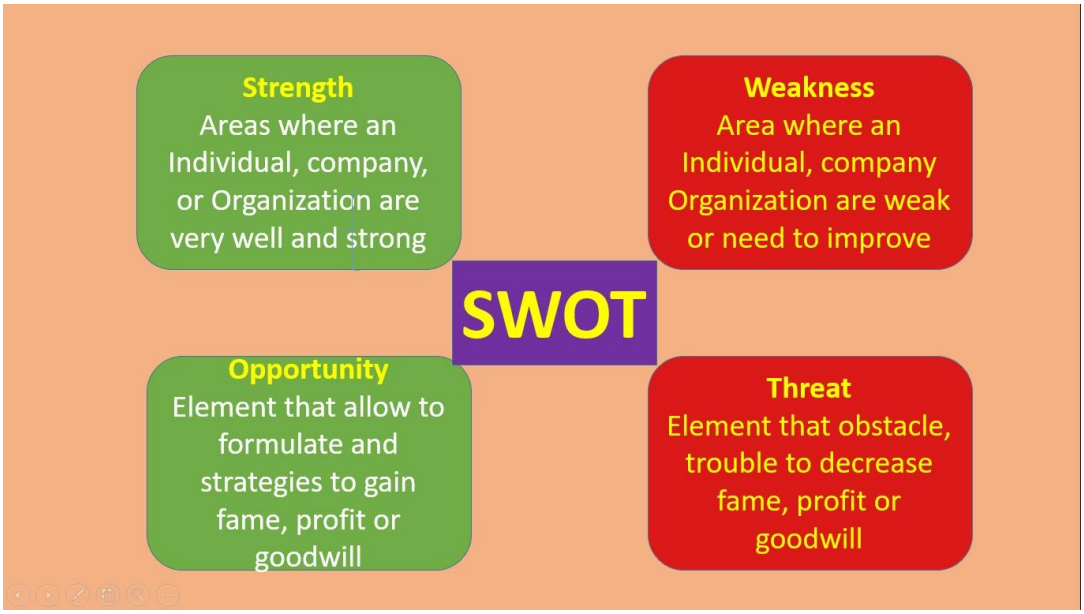


Fig. 1. PHD Academic Seekers Research Work SWOT Analysis (adapted from Creswell & Creswell, 2022)

Literature Review: The digital transformation of science has been highlighted in the works of various scholars who emphasize the transition to the "Digital Scholar" concept, where Open Access and network interaction are key factors (Weller, 2020). Recent studies suggest that digital tools significantly shape the identity and journey of doctoral seekers (Gupta & Khanna, 2024). However, the specific nature of PhD research—as a process of forming an independent scientist within a digital landscape—requires a more detailed study of the "multiple roles" these technologies play within modern digital learning ecosystems (Siemens & Dawson, 2022).

Recent scholarship highlights that AI is a daily reality in PhD workflows (Bozkurt, 2023). Current literature emphasizes the transition to the "Digital Scholar" concept, where Open Access and network interaction are key (Weller, 2020). While some argue AI democratizes research by assisting non-native English speakers, others warn of the "black box" nature of AI algorithms which can lead to biased results or "hallucinations" (Zawacki-Richter & Jung, 2023).

The digital transformation of science and its direct impact on graduate education have been highlighted in the works of various contemporary scholars. A foundational concept in this domain is the transition to the digital scholar model, where open access, digital identity, and global network interaction are established as the key factors of modern scientific development. Recent studies strongly suggest that digital tools no longer exist on the periphery of academia but actively shape the identity, academic journey, and daily workflows of doctoral seekers.

However, the specific nature of PhD research—viewed as a complex process of forming an independent scientist within a rapidly shifting digital landscape—requires a more detailed study of the multiple roles these technologies play within modern digital learning ecosystems. While traditional educational technologies focused on information delivery, modern academic environments rely on intelligent systems that interact with the researcher at an epistemological level.

Recent scholarship highlights that artificial intelligence has transitioned from a futuristic concept into a daily reality within PhD workflows. Current literature emphasizes that this shift offers unparalleled advantages but also introduces profound structural challenges. While some researchers argue that generative artificial intelligence democratizes international research by assisting non-native English speakers in articulating complex scientific concepts, others warn of the black box nature of artificial intelligence algorithms. This lack of algorithmic transparency can systematically lead to biased analytical results, data manipulation, or the complete fabrication of academic facts. Therefore, current literature demonstrates a significant gap in establishing unified ethical boundaries for advanced digital tool usage.

III Results

The study identified three key roles of digital means in the work of a PhD seeker:

1. *Cognitive-Analytical Role:* The use of Artificial Intelligence (AI) and intelligent data analysis systems allows for the processing of data volumes that are impossible to analyze manually, thereby increasing the depth of scientific inquiry (Bozkurt, 2023).

2. Organizational-Managerial Role: Bibliography management tools and planning software form a Personal Learning Environment (PLE) that minimizes technical errors in citation and text structuring, facilitating higher student engagement (Bond & Bedenlier, 2020).

Communicative-Reputational Role: Scientific social networks and digital identifiers ensure the visibility of research and facilitate academic mobility and global collaboration in the transition from traditional to tech-enhanced research (Sutherland & Smith, 2023).

Opportunities (The Catalyst Role)

1. *Literature Synthesis:* AI tools allow PhD seekers to navigate thousands of papers and identify gaps in literature with unprecedented speed (Sutherland & Smith, 2023).

2. *Code and Data Automation:* For STEM candidates, AI-driven coding assistants accelerate the development of research software and complex data visualization (Siemens & Dawson, 2022).

3. *Language Democratization:* AI acts as a sophisticated proofreader, helping international students articulate complex ideas in academic English (Bond & Bedenlier, 2020).

4. Threats (The Risk Factor)

5. *AI-Generated Plagiarism (Mosaic Plagiarism):* AI often paraphrases existing works, creating "mosaic" text. While it may pass simple similarity checks, the ideas remain uncredited (Gupta & Khanna, 2024).

6. *Fabricated Citations:* AI may generate links to non-existent articles, complete with fake DOIs, undermining scientific validity (Bozkurt, 2023).

7. *Data Privacy and IP Risks:* Uploading unpublished research data into public AI models poses significant intellectual property risks and violates many university ethics protocols (Tab. 1) (Zawacki-Richter & Jung, 2023).

Table 1. Catalyst Roles and Rist Factors of Digitalization in Academic Researches

Tool Name	Primary Purpose	Key Benefit for PhD	Potential Threat/Risk
ChatGPT / Claude	General Writing	Brainstorming and structuring.	High risk of hallucinations.
Elicit / Perplexity	Literature Review	Finding and summarizing papers.	May miss niche/new papers.
Scite.ai	Citation Analysis	Verifying if a claim is contested.	Over-reliance on summaries.

IV Discussion

The discussion of the results indicates that despite the obvious advantages, the digitalization of PhD research also presents challenges. There is a risk of "technological determinism," where the choice of research method is dictated by available software rather than scientific necessity. Furthermore, the ethics of using Generative AI in academic writing remains a critical point of debate (Bozkurt, 2023). Discussions within the academic community emphasize that universities must not only provide software but also cultivate critical digital literacy among candidates through comprehensive handbooks on digital education (Zawacki-Richter & Jung, 2023).

The primary point of contention is where "legitimate assistance" ends and "academic misconduct" begins. Discussion suggests that the "Multiple Role" of digital means must be governed by transparency. If a PhD seeker uses AI for structural brainstorming, it may be acceptable; however, using AI to draft the "Research Findings" section undermines the candidate's status as an independent researcher (Bozkurt, 2023). Universities are now tasked with moving from "AI prohibition" to "AI literacy," teaching candidates how to cite AI usage as part of their methodology (Fig. 2) (Henderson et al., 2021).

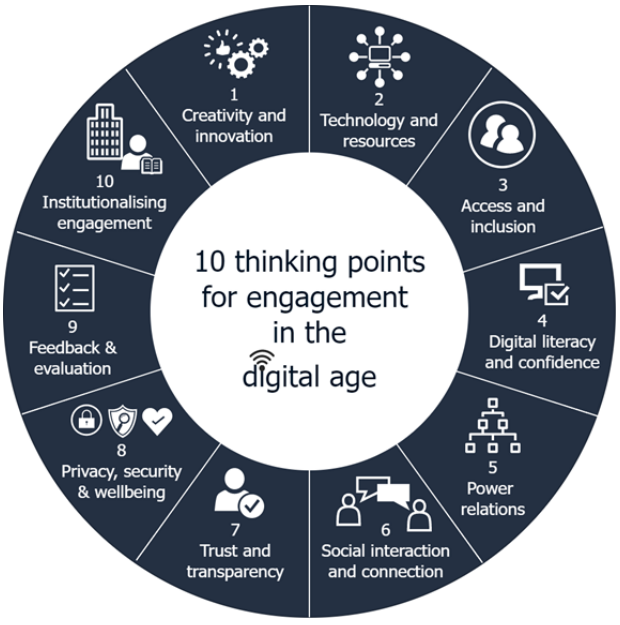


Fig. 2. PHD Thesis Engagement in the Digital Age (reprinted from Hafferty, 2022)

The image presents "10 Thinking Points for Engagement in the Digital Age," an evidence-based framework developed by Dr. Caitlin Hafferty. It is designed to help practitioners, policymakers, and organizations navigate the complexities of public and stakeholder engagement as it increasingly moves into digital and remote environments.

The framework emphasizes that digital engagement is not a "one-size-fits-all" solution; while it can increase efficiency, it also introduces new risks of exclusion and marginalization.

Key Dimensions of the Framework

The 10 points are categorized to address both technical requirements and ethical responsibilities:

- *Inclusivity & Access:* Points 3 (Access and inclusion) and 4 (Digital literacy and confidence) highlight the "digital divide." The framework notes that while digital tools can overcome geographical barriers, they often marginalize those who lack stable internet access or the confidence to use complex technologies.
- *Social Dynamics:* Points 5 (Power relations) and 6 (Social interaction and connection) explore how digital settings change human interaction. Research suggests that digital platforms can restrict social cues (like body language), making it harder to build deep rapport or address power imbalances compared to in-person meetings.
- *Ethics & Trust:* Points 7 (Trust and transparency) and 8 (Privacy, security & wellbeing) focus on the integrity of the process. It can be more difficult to establish trust with new groups online, and practitioners must actively manage risks related to data ownership, anonymity, and participant mental health.
- *Strategy & Evaluation:* Points 1 (Creativity and innovation), 2 (Technology and resources), 9 (Feedback & evaluation), and 10 (Institutionalising engagement) deal with organizational implementation. The framework advocates for a hybrid approach—combining digital and in-person methods—and insists that engagement be treated as a continuous, long-term process rather than an "add-on" activity (Tab. 2).

Table 2. *Image Analysis Summary*

Category	*Core Insight*
Primary Goal	To understand "what works" in participatory technologies for decision-making.
The "Hybrid" Rule	Success often requires a flexible blend of digital and physical methods to maximize reach and depth.
Human Centricity	Technology is a tool, not the goal; effective engagement still relies on high-quality facilitation and empathy.
Category	Core Insight

The findings of this study confirm that the digital transformation of higher education has moved beyond the simple adoption of hardware, completely shifting the paradigm of doctoral training. However, this transition is far from seamless, as the integration of advanced IT solutions into PhD research introduces a complex web of epistemological, pedagogical, and ethical dilemmas that demand critical academic scrutiny.

The Risk of Technological Determinism in Methodology. A primary concern emerging from the systematization of digital workflows is the growing risk of technological determinism. In modern academic environments, there is a subtle but dangerous tendency where the choice of research design or methodology is dictated by the availability of specific analytical software rather than genuine scientific necessity. For instance, a PhD candidate might alter their research questions simply to fit the capabilities of a particular data visualization tool or qualitative analysis package. This inversion of the traditional research workflow threatens the epistemological foundations of independent scholarship, as the tool begins to shape the inquiry, rather than the inquiry leveraging the tool.

The Fine Line Between AI Assistance and Academic Misconduct. The most critical point of contention within the academic community centers on where legitimate, ethical assistance ends and academic misconduct begins. As demonstrated in this study, the multiple roles of digital means must be governed by complete transparency. A clear boundary must be established based on intellectual contribution:

- *Acceptable AI Utilization:* Utilizing artificial intelligence for structural brainstorming, refining search queries during literature reviews, or correcting syntax and grammar variations to democratize academic English for international students.
- *Unacceptable AI Exploitation:* Outsourcing the intellectual core of the dissertation to algorithms. Using generative models to draft original research findings, interpret empirical data, or formulate novel hypotheses undermines the status of the candidate as an independent researcher and invalidates the academic degree.

Institutional Transition: From AI Prohibition to AI Literacy. The analytical comparisons in this paper indicate that traditional university honor codes are outdated and ill-equipped to handle the nuances of generative technologies. The historical response of higher education institutions—characterized by panic and total AI prohibition—has proven completely ineffective. Because algorithms can disguise paraphrased text through complex mosaic structures, simple text-matching software cannot reliably detect unauthorized usage.

Therefore, modern universities are tasked with moving toward comprehensive AI literacy. This involves teaching candidates how to transparently document and cite AI usage within their methodology sections, treating the algorithm as an technical tool rather than a hidden author.

Comparative Analysis with Existing Literature. The outcomes of this research align with and expand upon the digital scholar concept proposed in contemporary literature. While some scholars highlight the democratizing power of online networks and open access platforms, our SWOT analysis adds a necessary layer of caution regarding the "black box" nature of AI tools.

Furthermore, the structural components mapped out in this study complement the evidence-based framework for digital engagement, which stresses that technology must remain user-centric and human-facilitated. Technology is merely an accelerator; effective academic mentoring, peer critique, and deep scientific empathy remain the irreplaceable core of doctoral guidance.

V Conclusion

Digital means in the work of a PhD candidate play a multiple role: they act simultaneously as a tool, an environment, and a communication channel.

– *Outcome #1:* Digital literacy has become an essential part of the researcher's qualification (Haleem et al., 2022).

– *Outcome #2:* The efficiency of a doctoral student's work depends directly on the integration of specialized IT solutions into daily practice (Henderson et al., 2021).

– *Outcome #3:* Modern universities should shift their focus from simple technical equipment to creating comprehensive digital support platforms for young scientists (Siemens & Dawson, 2022).

– The integration of AI in PhD research is inevitable, yet it requires a robust ethical framework.

– *Outcome #4:* AI should be viewed as a co-pilot, not a ghostwriter. Intellectual responsibility remains solely with the PhD candidate (Haleem et al., 2022).

– *Outcome #5:* The efficiency of a doctoral student's work depends on the integration of specialized IT solutions, but must be accompanied by AI Ethics Modules (Gupta & Khanna, 2024).

– *Outcome #6:* Modern universities should shift their focus to creating comprehensive digital support platforms that prioritize viva voce (oral exams) to verify authentic contribution (Siemens & Dawson, 2022).

The study has successfully systematized the multidimensional functions of digital platforms within PhD workflows and evaluated the delicate balance between AI-driven research catalysts and their academic integrity risks through a systematic SWOT analysis.

Based on the research objectives, the following core outcomes have been established:

- *Outcome #6:* Digital tools in modern doctoral environments are no longer merely auxiliary aids but form a cohesive framework operating across three primary dimensions: cognitive-analytical, organizational-managerial, and communicative-reputational. The efficiency of a doctoral candidate's work directly depends on the integration of these specialized IT solutions into daily scientific practice.
- *Outcome #7:* While generative AI and Large Language Models provide powerful catalyst opportunities, they simultaneously introduce critical threats to academic integrity, including mosaic plagiarism, fabricated citations, and data privacy violations.

- *Outcome #8:* To maintain the validity of independent doctoral research, higher education institutions must urgently pivot from AI prohibition to critical AI literacy. Universities should transition toward comprehensive digital support platforms that prioritize robust ethical frameworks, AI Ethics Modules, and a greater emphasis on oral examinations to rigorously verify the authentic personal contribution of the candidate.

*Future Research Directions***.** Subsequent academic investigations should focus on the following key areas:

1. *Ethical Boundaries:* Developing granular institutional guidelines that define the exact operational threshold where legitimate AI assistance ends and academic misconduct or ghostwriting begins.
2. *Detection Methodologies:* Engineering advanced algorithmic workflows capable of identifying uncredited, AI-paraphrased ideas and verifying the absolute validity of AI-generated citations.
3. *Data Security Frameworks:* Designing encrypted, university-sanctioned AI environments that fully protect intellectual property and eliminate data privacy risks when uploading unpublished doctoral datasets.
4. *Curriculum Design:* Evaluating the long-term impact of integrating specialized AI Ethics and Literacy Modules into postgraduate curricula on the overall quality of PhD dissertations.

Future research should focus on establishing a clear boundary between "AI-assisted" and "AI-generated" work. This involves developing robust ethical frameworks that ensure intellectual responsibility remains solely with the PhD candidate while acknowledging AI as a "co-pilot" rather than a ghostwriter.

There is a need to study the transition from "AI prohibition" to "AI literacy." Research should explore how universities can cultivate critical digital literacy and teach candidates how to transparently cite AI usage within their research methodologies.

Further investigation is required into the risks of "technological determinism," where software availability might dictate research methods over scientific necessity. Additionally, strategies must be developed to address:

- *Mosaic Plagiarism: Identifying uncredited ideas in AI-paraphrased text.*
- *Hallucinations: Verifying the validity of AI-generated citations and data.*
- *Data Privacy: Protecting intellectual property when using public AI models.*

Research should examine the shift from providing simple technical equipment to creating comprehensive digital support platforms. These platforms should prioritize authentic contribution, potentially through increased reliance on oral exams (viva voce) to verify a candidate's independent work.

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