Responsible AI for doctoral researchers: Institutional strategies, supervision and skills in UK universities (2024–2025)

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Abstract

This qualitative study explores how artificial intelligence (AI) and digital technologies are reshaping postgraduate researcher (PGR) development and supervision in UK universities. Drawing on comparative case studies from institutions including University College London, Oxford, Cambridge, Manchester, Edinburgh, and King's College London, the study examines AI-assisted writing and data analysis, digitally mediated supervision, and evolving research practices. The findings show that universities are increasingly integrating AI to support doctoral researchers' productivity and analytical work, while introducing policies and training to safeguard academic integrity, authorship, and scholarly responsibility. At the same time, concerns emerge around academic identity, ethical AI use, and researcher development. Interpreted through digital literacy, ethical AI, and critical pedagogy perspectives, the study proposes a strategic framework for responsible and inclusive AI integration that positions AI as a support for rather than a substitute for the human scholarly journey. We analysed publicly available institutional AI policies, doctoral school guidance pages, training/workshop webpages, and related press releases (downloaded between October 2024 and January 2025). Cases were selected purposively as research-intensive UK universities with visible doctoral-level AI guidance and/or structured AI-related training.

1. Introduction

Doctoral education is undergoing a significant transformation in the digital age. Advances in artificial intelligence (AI) and digital platforms are reshaping how postgraduate researchers (PGRs learn, conduct research, and engage with supervision. Traditionally, doctoral training has been grounded in human mentorship, independent inquiry, and largely manual research practices (Akbar, 2025). Today, AI tools increasingly support academic writing, literature reviewing, data analysis, and aspects of research management, offering opportunities for greater efficiency, creativity, and collaboration (Holmes et al., 2023). At the same time, these developments raise serious questions about authorship, academic identity, and research integrity, prompting universities and policymakers to reconsider how AI can be integrated without undermining the educational purpose of the PhD (QAA, 2023).

While generative AI tools such as ChatGPT have been rapidly adopted by students and researchers for drafting, coding, and summarising literature, doctoral education has received comparatively limited attention in the growing AI-in-education literature. Emerging evidence suggests that many PhD researchers, as well as supervisors and examiners, feel underprepared to use AI responsibly, and that clear doctoral-level guidance remains uneven across institutions (UKCGE, 2024; Vitae, 2023). This gap highlights an urgent need to examine AI use specifically within the PGR context, where the stakes of authorship, originality, and scholarly development are particularly high.

Universities have begun responding through targeted policies and guidance. For example, the University of Oxford has issued a generative AI policy emphasising transparency, rigour, and ethical responsibility in research, while University College London explicitly requires doctoral researchers to declare significant AI assistance and stresses that AI use must "complement and not substitute" researcher development (UCL, 2023). These policies reflect a shared attempt to balance innovation with the formative aims of doctoral education: developing independent, critical scholars rather than outsourcing intellectual labour to automated systems.

Against this backdrop, this paper explores how AI and digital technologies are being integrated into researcher development across several UK universities, including UCL, Oxford, Cambridge, Manchester, Edinburgh, and King's College London. Using a qualitative, comparative case-study approach, the study examines AI-assisted writing and analysis, digitally mediated supervision, and evolving support practices. The analysis is informed by theoretical

perspectives on digital literacy, ethical AI, critical pedagogy, and professional identity development, and is situated within recent policy developments from UKRI, QAA, Vitae, and UNESCO (UNESCO, 2021; UKRI, 2024). The study aims to identify emerging practices, tensions, and principles that can inform a responsible and inclusive framework for AI integration in doctoral education. This paper asks: (1) What institutional strategies are used to integrate AI into doctoral development? (2) What challenges do supervisors and PGRs report? (3) What practical framework can guide responsible implementation?

While recent institutional and sector reports from the Quality Assurance Agency (QAA), UK Research and Innovation (UKRI), and Vitae have highlighted the rapid expansion of generative AI guidance in UK higher education, most existing discussions remain either policy-oriented or focused on undergraduate assessment integrity. Empirical mapping of how AI is being integrated specifically into doctoral researcher development remains limited and fragmented across institutional case examples.

Current literature shows that universities are moving at different speeds in producing AI policies, supervisor guidance, and training provision. However, these developments are often discussed in isolation, making it difficult to understand broader patterns across institutions, particularly regarding doctoral education where supervision, research integrity, and methodological innovation intersect. As a result, we still lack a comparative picture of how AI is shaping the doctoral training environment as a system rather than as isolated initiatives.

This study addresses that gap by offering a cross-case analysis of six UK universities, examining institutional strategies, training infrastructures, and supervisory implications for doctoral researchers. By combining document analysis with thematic synthesis, the paper moves beyond policy description to develop a practical, research-informed framework for responsible AI integration in doctoral education.

2. Methodology

2.1. Research Design

It was employed a qualitative, multiple case study design to explore the integration of AI in postgraduate researcher development across several leading UK universities. A case study approach was suitable because our aim was to generate an in-depth understanding of contemporary initiatives and experiences in specific real-world contexts. Each "case" in our study is a university (or, in some instances, a cross-university initiative) where notable efforts

have been made to incorporate AI or digital tools into doctoral training or supervision. By examining multiple cases, it was sought to identify patterns and divergences in approaches, facilitating a comparative analysis of practices across institutions. This comparative case method allowed for analytic generalization drawing broader insights and principles from the convergence of evidence across diverse settings rather than statistical generalization.

2.2. Case Selection

We selected six universities for in-depth case studies based on their established strength in doctoral education and demonstrated engagement with AI in researcher development. The institutions University College London, University of Oxford, University of Cambridge, University of Manchester, University of Edinburgh, and King's College London represent large, research-intensive universities across England and Scotland, allowing comparison across different institutional contexts. All are among the UK's leading recipients of research funding and have well-established doctoral training infrastructures, making them likely early adopters of AI-related innovation in postgraduate research (UKRI, 2024).

In addition to institutional cases, we included relevant national and multi-institutional initiatives as supplementary cases, most notably the Artificial Intelligence Researcher Development Network Plus (AI.RDN+), led by the University of Leeds and Aston University. Such initiatives provide cross-cutting guidance, shared resources, and sector-level influence that extend beyond individual institutions (AI.RDN+, 2024).

Case identification drew on multiple entry points: public announcements and press releases related to AI and doctoral education; institutional policy documents and guidance on AI use in research; and participation in national forums and consultations, including those organised by UKCGE and Vitae. We also reviewed recent sector literature and higher education reporting (e.g. *Times Higher Education*, *University World News*, and professional academic blogs) to identify emerging practices and innovations (QAA, 2023). For each selected case, we collected multiple forms of documentary and contextual evidence to develop a rich, triangulated understanding of AI integration in researcher development.

2.2.1. *Data Collection*

The documentary corpus was constructed between October 2024 and January 2025. Institutional materials were downloaded and archived at the point of access to ensure consistency of analysis. These included AI policy documents, doctoral school guidance

webpages, research integrity statements, training and workshop pages, and publicly available institutional communications (e.g., blog posts, press releases, or staff interviews).

To improve transparency and reproducibility, each document was logged with its source type and retrieval date. Where websites were updated dynamically, the most recent stable version available at the time of download was used. Table 1 provides a summary of document types collected for each case university and their retrieval period.

Case universities were selected through purposive sampling, focusing on research-intensive UK institutions that had publicly visible AI-related guidance or structured training provision relevant to doctoral researchers. For each institution, systematic searches were conducted using combinations of terms such as "AI policy," "doctoral training AI," "research integrity AI," and "supervision AI guidance." Only publicly accessible institutional materials were included. Documents were retained if they explicitly addressed AI use in research, supervision, doctoral skills training, or academic integrity contexts.

- **Document Analysis:** We gathered official documents such as university policies, guidelines, and strategy papers related to AI usage in research or education. For instance, Oxford's published *"Policy for using Generative AI in Research"* provided detailed insight into that institution's stance. UCL's Doctoral School webpage on generative AI and authorship gave practical guidance and examples of expected practice. King's College London had online guidance for doctoral students and supervisors on generative AI in thesis writing and assessment. We also reviewed relevant sections of university websites (e.g., doctoral college pages, library guides) and any available internal reports on researcher development programs incorporating digital tools.

- **Interviews and Testimonials:** Where available, we drew on interviews, Q&A articles, or testimonials of staff and students. For example, a *Phys.org* interview with researchers from Chalmers University (collaborating with University of Glasgow) discussed how doctoral students maintain their voice when using AI, underscoring the importance of peer interaction. Although not all case universities had published interviews, we integrated quotes from academic leaders found in press releases such as Professor Arunangsu Chatterjee at Leeds emphasizing a collaborative approach to ethical AI adoption in doctoral research, or Dr. Skye Xin Zhao at Manchester

highlighting the need for *"a responsible, ethical relationship with AI"* in researcher development.

No new human-subject interviews were conducted as part of this study. Any interview excerpts or testimonials referenced in the analysis were drawn exclusively from publicly available institutional communications (e.g., published Q&A articles or university news features). As the study relied solely on publicly accessible documentary materials, formal ethical approval for human subjects' research was not required.

- **Initiative Descriptions:** Many cases involved specific programs or projects. We collected descriptive information on these: for instance, Manchester's participation in developing UNESCO's AI competency frameworks and their library-supported AI literacy program; UCL's part-time PhD and research assistant post in AI in Education which blends doctoral research with building an AI tool for learning; the cross-university Next Generation Research SuperVision (RSVP) project on the future of doctoral supervision (linked to Research England funding); and the AI Research Foundations curriculum co-created by UCL and Google DeepMind to train researchers in generative AI, with an emphasis on responsible innovation.

- **Workshops and Training Content:** We examined available training schedules or materials to see how digital skills and AI feature. For example, Robert Gordon University (as a supplementary case outside the main sample) publishes its researcher development workshop listings, which in 2024–25 included sessions like *"Generative AI and the Researcher: Strategies, Insights and Practical Uses"* and *"Grant Writing Reimagined: Unlocking Success with AI Innovations"*. This provided a sense of the topics being addressed with PGRs and early-career researchers. Similar themes were cross-checked in the offerings of the larger case universities whenever possible (often through internal calendars or program outlines mentioned on websites).

- **Policies and External Guidelines:** To incorporate the policy dimension, we collected relevant guidelines from bodies such as UKRI, QAA, Vitae, and UNESCO. For example, we reviewed UKRI's policy on the use of generative AI in funding applications (which, while focused on grant writing, signals the official stance on disclosure and accuracy). We also included QAA's publications like *"Maintaining quality and standards in the ChatGPT era"* for sector-wide advice, and UNESCO's *AI Competency Frameworks* (for students and teachers) to gauge international expectations for AI literacy.

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2.2.2. *Data Analysis*

Our analysis proceeded in two main stages: within-case analysis and cross-case thematic analysis. First, for each university case, we synthesized the data into a narrative description capturing its key AI-related activities, tools, rules, and any notable outcomes or issues. We paid attention to the unique context of each institution: e.g., Oxford's formal policy development process involving roundtables with researchers and an AI advisory group, or King's College London tailoring guidance to doctoral assessment scenarios. Writing these case profiles allowed us to treat each as a stand-alone illustration of how AI integration is unfolding in PGR development.

Coding was conducted by the author using, MAXQDA, a structured thematic analysis process supported by digital annotation and spreadsheet-based coding tools. The analysis proceeded in two stages. The first stage involved open coding to identify recurring concepts and institutional practices across the dataset. The second stage involved focused coding, where initial codes were grouped into higher-level thematic categories and compared across cases.

Throughout the process, analytic memos were used to document interpretive decisions and emerging relationships between codes. A subset of coded extracts was revisited after an interval period to check consistency of interpretation, supporting internal reliability of the coding framework.

Next, we conducted a thematic analysis across all cases. Using an inductive coding approach, we read through the case evidence and coded text segments for recurrent concepts or strategies. Six major thematic categories emerged, which structure the Results section of this paper: (1) Institutional Strategies and Initiatives (covering how universities are strategically approaching AI, through projects, funding, and infrastructure); (2) AI Tools for Academic Writing and Literature Review; (3) AI in Data Analysis and Research Workflows; (4) Evolving Supervision and Mentorship with AI; (5) Challenges to Authorship, Identity and Integrity; and (6) Developing Digital Literacy and AI Competencies. These themes were not predetermined but

arose from patterns observed for example, multiple cases mentioned new writing support tools, prompting a category on writing; many also spoke to ethical concerns, prompting a category on challenges.

Throughout the analysis, we iteratively refined these themes by comparing them with theoretical constructs. We mapped where each theme intersected with our chosen frameworks: for instance, the digital literacy framework informed our interpretation of themes 2 and 6 (which deal with skills in using AI tools); ethical AI principles were especially relevant to theme 5 (challenges and integrity measures); critical pedagogy provided a lens for theme 6 and parts of theme 4 (ensuring reflective and inclusive practices in teaching with AI); professional identity development was woven into theme 5 (how AI impacts the researcher's sense of authorship and expertise). We thus used a combination of inductive coding from the data and deductive referencing to theory, in a process of *abductive analysis* moving back and forth between empirical observations and conceptual understanding.

Validity strategies were employed to enhance trustworthiness. We used *member checking* in a limited form by comparing our interpretations with public statements of practitioners. For instance, Dr. Baraa Khuder's published reflections on teaching with AI emphasizing that "writing with AI... is about learning to navigate it critically, ethically, and intelligently" served as a check that our critical interpretation of AI's role in writing instruction was in line with expert intent. We also ensure *thick description* by including direct excerpts from sources (policies, quotes) to let the reader see evidence backing our analytic claims. All source material is cited for transparency.

Ethical considerations: All data were drawn from publicly accessible documents or published materials; no confidential information was used. The study did not involve human subjects directly, so institutional ethics approval was not required. However, we approached institutional cases with sensitivity, recognizing that policies and practices are evolving. Where policies or quotes might reflect a specific moment in time (e.g., a 2023 guideline that could later change), we note the timing to avoid misrepresentation. The goal is not to evaluate or rank universities, but to learn from each an ethic of appreciative inquiry guides our tone, even as we critically examine challenges.

As this study relied on documentary data, traditional participant member-checking was not feasible. Instead, credibility was strengthened through source triangulation, whereby

interpretations were cross-checked across multiple document types within each institution (e.g., policy statements, doctoral guidance, and public communications). This process reduced the risk of misinterpretation and supported the robustness of cross-case comparisons. An audit trail of coding decisions and thematic development was also maintained to enhance transparency. Figure 1 illustrates the methodological process used to construct and analyse the institutional corpus.
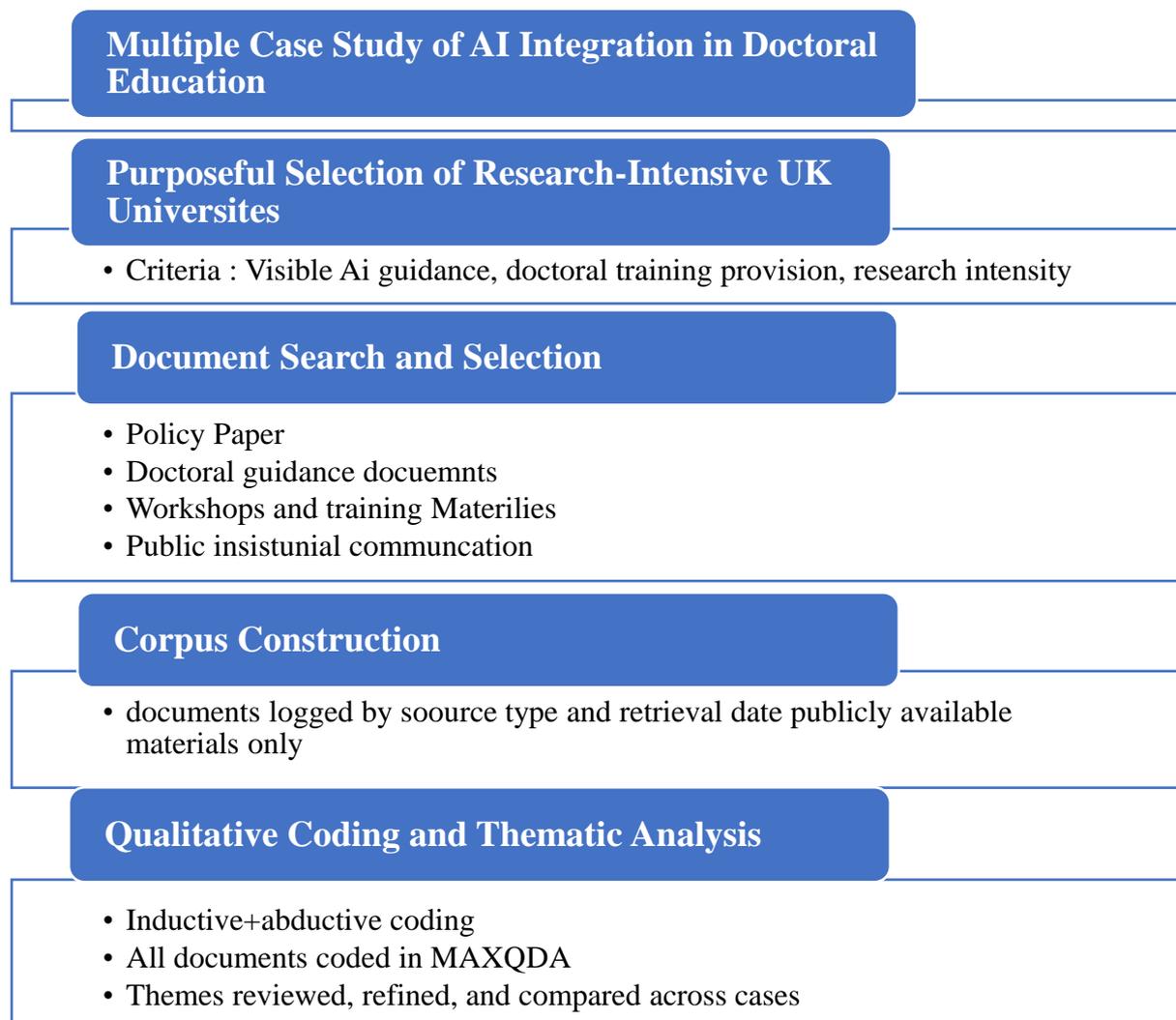
Multiple Case Study of AI Integration in Doctoral Education

Purposeful Selection of Research-Intensive UK Universites

- Criteria : Visible Ai guidance, doctoral training provision, research intensity

Document Search and Selection

- Policy Paper
- Doctoral guidance docuemnts
- Workshops and training Materilies
- Public insistunial communcation

Corpus Construction

- documents logged by soource type and retrieval date publicly available materials only

Qualitative Coding and Thematic Analysis

- Inductive+abductive coding
- All documents coded in MAXQDA
- Themes reviewed, refined, and compared across cases

Figure 1. *Methods Flowchart*

In the following Results section, we present the thematic findings with illustrative examples from the cases. The Discussion then interprets these findings in light of broader frameworks and policy, and the Conclusion offers strategic recommendations synthesizing the insights from this multi-case exploration.

3. Thematic Findings

Through analysis of the case studies, we identified six major themes that characterize how AI and digital technologies are transforming doctoral researcher development and supervision across UK universities. These themes often cut across institutional lines suggesting common opportunities and challenges but specific examples from individual universities illustrate the diversity of approaches. Below, we discuss each theme in turn, integrating case evidence and noting similarities or differences among the institutions studied. Table 1 lists the six case universities, the types of documents collected, and the key AI initiatives identified. Table 1 shows variation in the level of policy formalisation and doctoral training provision across institutions.

Table 1. *Case Corpus Overview*

University	Document Types Collected	AI-Related Focus	Evidence Lines
Oxford	AI policy page; Research integrity guidance; Doctoral training workshop page	Responsible AI use in research writing and supervision	Policy webpage; Integrity guidance; Doctoral skills training page
Cambridge	Research integrity guidance; Faculty AI statements	Ethical framing of AI in research practice	Research integrity page; Faculty guidance notes
UCL	Doctoral school AI guidance; Digital skills training pages	AI in doctoral skills and academic writing development	Doctoral training pages; Skills workshop listings
Manchester	AI research methods support; Training workshops; Policy guidance	AI tools for research workflows and methods	Research methods pages; Training event listings
Edinburgh	Ethics and integrity statements; Digital scholarship support pages	Ethical AI integration in research practice	Research ethics guidance; Digital scholarship resources
Imperial	Research computing and AI tools support; Doctoral training resources	Technical AI applications in research and data analysis	Research computing guidance; Training resources

3.1. Institutional Strategies and Initiatives for AI Integration

A clear theme is the strategic, top-level initiatives universities are launching to integrate AI into researcher development. Rather than ad-hoc adoption by individual students or supervisors, many institutions have begun coordinated programs or networks to guide the use of AI in doctoral education.

Several universities have established multi-institutional collaborations to pool expertise and resources. A standout example is the Artificial Intelligence Researcher Development Network Plus (AI.RDN+), a project led by the University of Leeds in partnership with Aston University

and supported by Research England. Launched in 2025 with £3.4 million funding, AI.RDN+ brings together 20 universities (eight from the Midlands Innovation consortium and 12 from the Yorkshire Universities group) to *"ensure AI adoption in doctoral research is innovative, ethical and delivers real benefit"*. This network's goals include surveying current AI tool usage among PhD researchers, identifying best practices, and developing shared resources and training for the sector. It explicitly addresses the gap in guidance for doctoral-level AI use, noting that PGRs and supervisors have felt uncertain without clear direction. By co-creating guidance and training across institutions, the AI.RDN+ initiative exemplifies a proactive, collaborative strategy: rather than each university reinventing the wheel, the network will create a central knowledge hub (an AI.RDN+ portal) and leverage collective insights for the benefit of all members. The involvement of national bodies like Jisc (the UK's digital education agency), UKCGE, and Vitae as partners indicates alignment with broader research culture and skills agendas. This kind of strategic networking suggests that AI in researcher development is being treated not just as a local issue, but as a national developmental priority.

At the individual university level, many cases reveal dedicated programs or roles focused on AI in education. For instance, University College London (UCL) has signaled its commitment by creating new positions that bridge research and practice. In late 2025, UCL advertised a combined part-time PhD studentship and research assistant role centered on *"AI-supported learning in ophthalmology"*. This innovative role embeds a doctoral trainee within an educational technology project to develop an AI-driven intelligent tutoring system for medical education. As described by Professor Mutlu Çukurova of UCL, the candidate will both *"build and assess a large language model (LLM)-based system to support students"* and study how learners interact with it Boyd and Harding, 2025). The project combines technical development (e.g. coding an AI tutor, implementing *guardrails* for safe use) with educational research (interviews, classroom trials on responsible implementation). By structuring a PhD around the creation of AI tools for learning, UCL is integrating researcher development *into* the very process of AI innovation. The doctoral student is not just a user of AI, but a co-designer gaining cutting-edge skills in AI, while also helping the university understand AI's impact on learning. Such initiatives indicate a forward-looking strategy: universities are funding research that simultaneously trains scholars and yields practical AI applications for education. This aligns with UCL's broader digital education strategy and its values of responsible innovation (King's College London, 2023).

Other institutions have launched curriculum initiatives to broaden AI training. UCL again provides an illustrative case with its collaboration with Google DeepMind on the "AI Research Foundations" program. Announced in October 2025, this free online curriculum was co-developed to *"equip the next generation of researchers with a deep understanding of generative AI and LLMs"*. While targeted at advanced undergraduates through early-career researchers globally, it specifically aims to lower barriers in regions like Africa by providing localized, open-access AI education (Molinari, Gooch and Tipi, 2025). The curriculum covers not only technical content (machine learning foundations, coding exercises, even fine-tuning a language model) but also includes *"responsible AI techniques"* and activities on ethical innovation. UCL's leadership emphasized their *"commitment to widening access"* and *"ensuring learners can apply skills to drive positive social impact"*. From a researcher development perspective, this initiative expands the pipeline of AI-savvy researchers and reflects an inclusive ethos recognizing that diverse participation in AI research strengthens the field. Notably, UCL's effort was done in partnership with industry (DeepMind) and African academic networks, signaling that cross-sector and global collaboration form part of institutional strategies to democratize AI knowledge (Boyd and Harding, 2025).

Likewise, the University of Manchester's approach shows strategic alignment with global policy development. Manchester has a faculty lead (Dr. Xin "Skye" Zhao) in Generative AI for Education who is directly working with UNESCO on new *AI competency frameworks* for students and teachers (UNESCO, 2023). By contributing to international guidelines, Manchester ensures its internal strategies are informed by and influence global best practice. A news report notes that Dr. Zhao's project will develop a *"scalable programme to support staff and students in building AI competency,"* in collaboration with the university library. This suggests Manchester is planning institution-wide training resources or workshops on AI literacy, informed by the survey of global perspectives she led. Additionally, Manchester is involving its *Institute of Education* and library to create a *"non-judgmental space"* for students and educators to reflect on AI use and share experiences. Strategically, this indicates an emphasis on culture-change and community dialogue as part of AI integration, not just top-down policy. By gathering user input (through global surveys and local forums) and feeding that into both UNESCO frameworks and local training, the initiative embodies a comprehensive strategy bridging policy and practice, as well as research and development functions of the university.

In terms of policy strategy, formal guidelines and policies have become a common institutional response. Several universities have crafted dedicated policies to clarify permissible AI use in research and teaching for their communities. The University of Oxford's policy, developed in 2023–24, is an example of a comprehensive approach. It set out that Oxford *"wishes to enable and support the safe and productive use of GenAI by the research community,"* with aims to provide *"clear guidelines for its integration into the research process."*. What stands out is the consultative process Oxford used: the policy was shaped via roundtable meetings with researchers from different disciplines and was reviewed by committees focused on research practice and an AI competency center. By drawing on funder and publisher policies as references, Oxford aligned its rules with external expectations (e.g., requiring adherence to research integrity concordats and data protection laws). The policy delineates *"substantive use"* of AI in research – which includes activities like data analysis, literature reviewing, hypothesis generation, coding, and drafting text versus ancillary use (such as minor language corrections or formatting) that might be exempt. This level of detail signals a strategic effort to integrate AI into every stage of the research lifecycle in a controlled manner, rather than banning it. The policy also extends to all researchers (staff and students) and even professional support staff who use AI to facilitate research, indicating a whole-university scope. By formally archiving the policy in Oxford's research archive and encouraging adaptation by others, the university positioned itself as a sector leader guiding policy dissemination.

King's College London (KCL) similarly developed guidance specifically targeting the doctoral context. KCL's *"Generative AI Guidance for doctoral students, supervisors and examiners"* was created to remove ambiguity about how generative AI can be used in thesis writing and examination. It explicitly asks: *"Are students allowed to use generative AI tools when writing their thesis?"* and lays out principles, scenarios, and integrity considerations. For example, KCL clarifies that use of ChatGPT or similar tools in writing must be appropriately disclosed and aligned with their academic misconduct policies. The guidance stops short of being a strict "policy" it's presented as dynamic advice that can evolve with feedback and technology changes. This approach of issuing living guidance rather than fixed rules could be strategic: it allows KCL to adapt quickly in the fast-changing AI landscape while giving the PGR community interim clarity. It also complements KCL's broader frameworks (they reference the King's Framework for PGR Awards and generative AI guidance for taught students to ensure consistency). The inclusion of examiners in the target audience is noteworthy it ensures that

those assessing doctoral work are aware of how AI may have been used and what is acceptable, thus aligning expectations across all stakeholders in the PhD process.

In sum, theme 1 shows universities are not passively reacting to students using AI; they are actively building structures networks, programs, policies to shape AI's role in doctoral education. These strategies often involve collaboration (internally across departments, and externally with other universities, industry, or international bodies) and are guided by principles of responsibility and inclusivity. There is an understanding that AI integration needs to be *enabled* (through resources and training) but also *managed* (through guidelines and community engagement) at an institutional level. The initiatives at Leeds/Aston (AI.RDN+), UCL, Manchester, Oxford, KCL, and others illustrate a broad commitment to harness AI for researcher development, with strategic oversight to ensure it aligns with academic values and enhances the doctoral experience

3.2. AI Tools for Academic Writing and Literature Review Support

The most widespread and institutionally accepted use of artificial intelligence in researcher development is in academic writing and literature review, which remain core activities for all doctoral researchers. Across universities, there is a growing consensus that generative AI tools can support the writing process, provided that their use is transparent and does not compromise academic integrity or authorship (University of Cambridge, 2023; UCL, 2023).

Generative AI writing assistants such as ChatGPT, Copilot, and other scholarly tools are increasingly used by doctoral researchers to support drafting, rephrasing, summarising sources, and improving linguistic accuracy. Rather than imposing outright bans, universities have largely adopted a conditional permission model. For example, guidance from the University of Cambridge clarifies that while the use of generative AI is not prohibited, the submission of AI-generated text without acknowledgement constitutes academic misconduct (University of Cambridge, 2023). In practice, this means that doctoral researchers may use AI tools for brainstorming or drafting, but only with appropriate disclosure and supervisory awareness. This position reframes AI as a writing aid rather than a substitute for scholarly thinking, with full intellectual responsibility remaining with the student.

This approach is articulated in greater procedural detail by the University College London (UCL). UCL's guidance explicitly requires doctoral researchers to acknowledge any use of generative AI that meaningfully contributes to content creation, such as structuring arguments

or drafting text (UCL, 2023). UCL has also updated its Doctoral Thesis Declaration Form to include a section on AI and other external support. Importantly, UCL repeatedly stresses that the doctoral researcher remains fully accountable for the accuracy, originality, and scholarly quality of the thesis, particularly given the documented tendency of generative AI systems to produce plausible but incorrect information or fabricated references (UCL, 2023; Elsevier, 2023).

Some universities have gone further by embedding AI writing support within secure institutional infrastructures. The University of Edinburgh, for example, provides students with access to "ELM" (Edinburgh Language Models), a secure gateway to vetted generative AI systems (University of Edinburgh, 2023). This approach addresses concerns around data privacy and intellectual property, enabling doctoral researchers to use AI tools for drafting or summarisation without uploading sensitive research materials to public platforms. Similar cautions are echoed by institutions such as MIT and Harvard University, which advise researchers not to input confidential or unpublished material into public AI tools (MIT, 2023; Harvard University, 2023).

AI-powered literature discovery tools such as Elicit, ResearchRabbit, and Scite have also gained prominence as aids for navigating increasingly large bodies of literature. These tools can assist with identifying relevant studies, mapping thematic patterns, and generating preliminary summaries (Perkins, 2023). However, universities consistently caution that AI outputs cannot be treated as authoritative sources. Guidance referenced by the Princeton University reiterates that generative AI should not be cited as a source and that researchers must verify all claims against original literature (Princeton University, 2023). This ensures that doctoral researchers remain actively engaged in interpretation, synthesis, and critical judgement core elements of doctoral-level scholarship.

Universities are also beginning to integrate AI explicitly into writing pedagogy and researcher development provision. Rather than leaving doctoral researchers to experiment independently, some institutions have incorporated AI use into structured writing courses and workshops. Evidence from a writing-for-publication initiative at the Chalmers University of Technology suggests that when AI use is embedded within a pedagogical framework emphasising peer feedback and reflection, doctoral researchers are better able to maintain disciplinary voice and authorial control (Hosseini et al., 2023). This aligns with broader calls for critical AI literacy,

which emphasise evaluative judgement, reflexivity, and ethical awareness rather than technical proficiency alone (Selwyn, 2024).

An important dimension of AI-assisted writing is its potential contribution to linguistic inclusivity. AI tools have been widely recognised as potentially beneficial for researchers writing in an additional language. Skipper (2023), editor-in-chief of *Nature*, argues that generative AI used with appropriate safeguards may help level linguistic inequalities in academic publishing by supporting clarity and fluency. While most universities remain cautious in policy language, publisher guidelines and institutional policies implicitly acknowledge this benefit by allowing AI use for language improvement, provided that such use is disclosed when it goes beyond routine proofreading (Elsevier, 2023; UCL, 2023).

In summary, AI tools for academic writing and literature review are now firmly embedded in doctoral research practice. Universities largely adopt an enabling but cautious stance, encouraging doctoral researchers to use AI to enhance efficiency, clarity, and confidence, while reinforcing expectations around transparency, verification, and intellectual ownership. The emphasis remains on preserving the researcher's academic voice and integrity, positioning AI as a supportive instrument rather than a source of scholarly authority. This provides a foundation for extending the discussion to AI use in later stages of the research workflow, including data analysis and methodological decision-making.

3.3. AI in Data Analysis and Research Workflows

Beyond academic writing, artificial intelligence and machine learning tools are increasingly embedded in the everyday practice of doctoral research, particularly in data analysis, coding, and research workflow automation. Evidence from institutional cases suggests that universities are beginning to formally recognise this shift as part of researcher development, through the provision of training, infrastructure, and guidance on responsible AI-assisted research (University of Cambridge, 2023; University of Edinburgh, 2023).

Across disciplines, contemporary PhD projects often involve large datasets or analytically complex materials, ranging from quantitative experiments to textual and visual data. AI techniques such as machine learning, natural language processing, and data mining are increasingly used to extract patterns, accelerate analysis, and manage research complexity. In response, universities have expanded provision of AI-related training. For example, the University of Cambridge supports researchers through initiatives such as the Cambridge Centre

for Data-Driven Discovery, which offers training in machine learning, data visualisation, and computational analysis to doctoral researchers across disciplines (University of Cambridge, 2023). Similarly, the University of Edinburgh has delivered doctoral-level workshops on AI-assisted methods such as text mining and qualitative data coding, often using institutionally licensed software and secure environments (University of Edinburgh, 2023).

At a structural level, the creation of Centres for Doctoral Training (CDTs) in data-intensive fields further signals that AI literacy is increasingly viewed as part of the expected doctoral skillset. Joint initiatives such as the EPSRC Centre for Doctoral Training in AI for Decision Making in Complex Systems, hosted by the University of Manchester and the University of Cambridge, provide structured training in machine learning, statistics, and responsible AI before students begin their research projects (EPSRC, 2023). While these programmes primarily train AI specialists, they also reflect a wider institutional assumption that familiarity with AI tools is becoming foundational rather than exceptional.

Importantly, the use of AI in research workflows is not confined to those formally studying artificial intelligence. Across disciplines, doctoral researchers increasingly use general-purpose AI tools to support programming, data cleaning, and exploratory analysis. Coding assistants such as GitHub Copilot or ChatGPT are now commonly used to generate scripts, debug code, or prototype analytical models. The emergence of the AI.RDN+ network explicitly acknowledges this reality, identifying the use of publicly available tools such as ChatGPT and Microsoft Copilot as a widespread feature of doctoral research that requires institutional guidance rather than prohibition (AI.RDN+, 2024).

University policies further illustrate how AI is becoming embedded in the research process itself. The University of Oxford's generative AI policy explicitly recognises AI use in activities such as data interpretation, hypothesis development, code generation, and the creation of synthetic datasets (University of Oxford, 2023). At the same time, the policy stresses that researchers must judge whether an AI tool is fit for purpose, highlighting the importance of digital and methodological literacy. This reflects a growing recognition that effective AI use requires understanding both the capabilities and limitations of different tools for example, distinguishing between pattern detection and causal inference.

Another notable development is the increased provision of institutional AI infrastructure. Universities are making cloud computing services, AI libraries, and high-performance

computing resources available to PGRs, often within secure environments. King's College London, for instance, provides guidance through its AI Hub on using AI tools responsibly, with particular emphasis on information security and data protection (King's College London, 2023). Similarly, institutional guidance at the University of Manchester encourages the use of secure university systems for any sensitive research data when deploying AI tools (University of Manchester, 2023). This infrastructure enables doctoral researchers to apply AI methods such as sentiment analysis or topic modelling without requiring advanced programming expertise, contributing to the broader democratisation of AI-enabled research.

Alongside technical provision, universities are increasingly fostering peer learning and interdisciplinary support around AI. Research centres, doctoral networks, and cross-institutional partnerships now offer training modules, events, and shared resources on data analytics and AI that are open beyond computer science disciplines. Initiatives such as UCL's AI-related doctoral networks and the planned training resources of the AI.RDN+ network aim to support doctoral researchers in applying AI methods critically and appropriately within their own fields (UCL, 2023; AI.RDN+, 2024).

Despite this supportive stance, institutional guidance consistently emphasises the risks and limitations of AI-assisted research. Universities warn that AI-generated analyses and code may contain errors, biases, or opaque assumptions, and therefore require careful human oversight. Guidance from MIT stresses that AI outputs should always be verified, while Harvard University reminds researchers that responsibility for any AI-generated content rests entirely with the user (MIT, 2023; Harvard University, 2023). These cautions are increasingly reinforced through researcher development provision addressing AI ethics, bias, and research integrity, including workshops and case-based discussions offered through organisations such as Vitae and the UK Council for Graduate Education (Vitae, 2023; UKCGE, 2023).

A further emerging area is the use of AI to generate synthetic data and simulations, particularly in fields where access to real-world data is limited by privacy, scale, or rarity. While policies such as Oxford's recognise synthetic data generation as a legitimate AI use case, they also imply the need for advanced skills in validation and interpretation (University of Oxford, 2023). This suggests that researcher development will increasingly need to address not only how to generate such data, but how to assess its validity and limitations.

In summary, this theme demonstrates that AI is becoming embedded in the doing of research, not merely in its presentation. Universities are responding by equipping doctoral researchers with access to tools, training, and infrastructure for AI-assisted analysis and automation, while simultaneously emphasising verification, ethical awareness, and researcher accountability. The result is an expanded research capability, coupled with a renewed focus on critical judgement and methodological competence. The following theme will extend this discussion by examining how AI is reshaping doctoral supervision and research collaboration.

3.4. Evolving Supervision and Collaboration Practices with AI

AI's influence on doctoral education increasingly extends beyond writing and data analysis to the relationships and practices of supervision and research collaboration. While doctoral supervision remains fundamentally human-centred, digital technologies many of which now embed AI functionalities are reshaping how supervisors and doctoral researchers interact, communicate, and work together. Universities are beginning to respond by adapting supervision training and guidance, with the aim of ensuring that AI supports rather than weakens the developmental core of the PhD (UKCGE, 2023; Vitae, 2023).

One significant development is the normalisation of hybrid and virtual supervision, accelerated during the COVID-19 pandemic and sustained through improved digital platforms. Although video conferencing tools are not inherently AI systems, many now integrate AI-driven features such as live transcription, automated captions, and meeting summaries. Universities including the University of Cambridge and the University of Oxford have invested heavily in platforms for remote supervision and document sharing, enabling supervisors to provide feedback through digital annotation and version tracking (University of Cambridge, 2023; University of Oxford, 2023). AI-enabled transcription tools, for example in Microsoft Teams, can help students revisit supervisory discussions particularly beneficial for those working in a second language or dealing with complex methodological advice provided consent and data protection requirements are met.

AI is also entering the supervisory feedback process, particularly around doctoral writing. Increasingly, students may use AI tools to improve clarity or structure before submitting drafts, while supervisors may use AI-assisted tools to check coherence, readability, or potential integrity issues prior to in-depth review. Guidance from King's College London includes scenario-based examples that explicitly address how supervisors and doctoral students should

negotiate AI use in writing, emphasising early discussion, transparency, and shared expectations (King's College London, 2023). This signals a shift in supervisory expertise: supervisors are now expected not only to advise on research content, but also to guide ethical and appropriate AI use.

In response, universities and sector bodies are incorporating AI-related issues into supervisor development and recognition programmes. Initiatives such as the UK Council for Graduate Education's Research Supervision Recognition Programme increasingly address supervision in digitally mediated contexts, including how supervisors should advise on disclosure, originality, and responsible AI use (UKCGE, 2023). The University of Manchester's involvement in surveys and consultations on AI policy development further suggests that supervisors' perspectives are shaping institutional guidance (University of Manchester, 2023).

AI is also beginning to influence how doctoral progress and assessment are supported, though universities remain cautious. Experimental tools can analyse patterns in data, track writing development, or compare draft versions, but there is limited evidence of formal AI-driven evaluation being adopted. Universities tend to prioritise educative over evaluative uses of AI, reflecting concerns about academic judgement, context, and academic freedom (QAA, 2023). Projects such as the Research England–funded Next Generation Research SuperVision (RSVP) initiative suggest growing interest in digitally augmented supervision, potentially including AI-supported agenda-setting or reflective prompts, but these developments remain exploratory (Research England, 2023).

Beyond the supervisor student relationship, AI is also reshaping doctoral collaboration and teamwork. In collaborative writing and international research groups, AI tools are used to support consistency of style, terminology, and language, particularly where collaborators have different linguistic backgrounds. Tools such as Grammarly or DeepL Write are often employed to harmonise drafts, while AI-supported project management systems can assist supervisors overseeing multiple doctoral researchers by tracking timelines and reminders (Elsevier, 2023). These practices subtly enhance efficiency while maintaining collective authorship.

Universities are also fostering communities of practice around digital and AI-enhanced supervision. For example, the University of Edinburgh has a strong tradition of offering professional development for supervisors through its Institute for Academic Development,

increasingly addressing online and AI-informed supervision (University of Edinburgh, 2023). Sector bodies such as Vitae and UKCGE similarly provide spaces for doctoral leaders to share approaches to supervising in the context of generative AI (Vitae, 2023).

Ethical mentorship has emerged as a particularly important dimension of supervision in the AI era. Supervisors are now expected to guide doctoral researchers on issues such as authorship (AI tools cannot be listed as authors), confidentiality (sensitive or unpublished data should not be uploaded to public AI platforms), and dependency (ensuring AI does not replace the development of independent scholarly judgement) (Harvard University, 2023; University of Cambridge, 2023). Guidance from institutions such as King's College London and UCL emphasises the value of early, open conversations about AI use, positioning supervision as a space for ethical formation rather than enforcement alone (UCL, 2023).

At the collaborative level, norms around disclosure of AI use are also evolving. Many research groups now explicitly report AI-assisted analysis or processing in their methods sections, in line with publisher requirements from journals such as *Nature* and *Science* (Nature, 2023; Science, 2023). Supervisors and principal investigators play a key role in socialising doctoral researchers into these emerging norms of transparency.

Looking ahead, there is growing speculation about whether AI could act as a form of supplementary advisor or tutor for doctoral researchers. While experimental AI tutors exist in some educational contexts, there is no evidence of universities adopting AI as a formal "co-supervisor." The prevailing stance remains that AI may provide informational or procedural support, but lacks the accountability, contextual judgement, and relational depth required of doctoral supervision (Selwyn, 2024). As one editor has noted, AI may assist, but it cannot take responsibility for a researcher's progress or sign off doctoral milestones.

In summary, this theme shows that doctoral supervision and collaboration are adapting to an AI-augmented research environment. Human relationships remain central, but supervisors are increasingly expected to advise on responsible AI use alongside research content. Universities are updating supervisor training, encouraging early dialogue and shared expectations, and cautiously exploring how digital and AI tools can enhance mentoring. Used well, these developments may enable more flexible, inclusive, and efficient supervision, while preserving the intellectual rigor and developmental purpose of doctoral education. The next theme turns to the challenges these changes pose for authorship, scholarly identity, and research integrity.

3.5. Challenges: Authorship, Academic Identity, and Research Integrity

The integration of AI into doctoral research brings clear benefits, but it also raises significant challenges around authorship, academic identity, and research integrity. Our analysis shows that these concerns are widely recognised across universities, and that institutions are actively responding through updated policies, guidance, and educational initiatives rather than reactive bans (QAA, 2023; UKCGE, 2023).

One of the most pressing challenges concerns authorship and attribution. In traditional scholarship, authorship implies responsibility, accountability, and ownership of intellectual work. The rise of generative AI complicates this model: if an AI tool contributes text, ideas, or visual outputs, how should that contribution be acknowledged? Early experiments in 2022–2023, where some papers listed "ChatGPT" as a co-author, were swiftly rejected by the academic community. Major publishers, including *Science* and *Springer Nature*, clarified that AI tools cannot be credited as authors because they lack agency, accountability, and legal responsibility (Nature, 2023; Science, 2023). Universities have aligned closely with this position. For example, University College London requires doctoral researchers to declare AI assistance separately, while making clear that authorship always rests with the human researcher (UCL, 2023).

Despite this clarity, grey areas remain. A doctoral researcher may substantially edit AI-generated text and feel that the final output is their own, yet the structure or phrasing may still have been shaped by the tool. Most universities therefore advise erring on the side of disclosure. Guidance from King's College London explicitly recommends declaring appropriate AI use in acknowledgements or methodology sections, while institutions such as University of Cambridge and Princeton University caution that failure to disclose permitted AI use may constitute a breach of academic integrity (University of Cambridge, 2023; Princeton University, 2023). A clear norm is emerging using AI is not inherently problematic; concealing its use is.

Concerns about integrity extend beyond text. When AI is used to generate or manipulate research outputs such as synthetic data, translated materials, simulations, or images transparency becomes essential. The QAA has urged universities to explicitly incorporate AI into academic integrity policies so that expectations are unambiguous (QAA, 2023). Sector-wide initiatives such as the AI.RDN+ network, led by the University of Leeds, aim to develop shared guidance on responsible AI use, particularly around attribution and disclosure (AI.RDN+, 2024).

Equally important are concerns around academic identity and scholarly voice. Doctoral education is not only about producing outputs but about becoming an independent scholar. Excessive reliance on AI risks flattening individual voice or weakening intellectual ownership. Empirical work from Chalmers University of Technology suggests that peer feedback and structured reflection can help doctoral researchers maintain ownership of their voice while using AI tools, but this requires conscious pedagogical effort (Hosseini et al., 2023). This aligns with broader arguments for critical AI literacy, which emphasise that researchers must understand AI's limitations, biases, and epistemic assumptions rather than treating outputs as authoritative (Selwyn, 2024).

Universities are increasingly reinforcing this stance in guidance. For example, the University of Glasgow frames AI as a tool that must remain under the researcher's intellectual control, while UCL stresses that doctoral researchers must always be able to explain which aspects of the work are their own and which involved computational support (UCL, 2023). Such guidance protects academic identity by insisting on reflexivity and ownership, even in AI-augmented workflows.

Research integrity also raises practical risks. AI-generated text may unintentionally reproduce uncited material, fabricate references, or introduce errors into data analysis. While tools such as Turnitin have introduced AI-detection features, universities remain cautious about over-reliance on detection technologies due to concerns about false positives and erosion of trust (QAA, 2023). Instead, the dominant approach favours education, transparency, and robust scholarly practices, with the doctoral viva remaining a key safeguard, as examiners can probe understanding and methodological decision-making directly.

Data integrity presents further challenges. Generative AI can fabricate plausible but false citations or generate synthetic data that do not accurately reflect real-world conditions. Universities and libraries therefore strongly caution doctoral researchers to verify all references and to treat AI-generated data with scepticism (Harvard University, 2023). At the same time, AI can be used positively to support integrity, for example by detecting anomalies in datasets or identifying potential image manipulation, underscoring its dual role as both risk and safeguard.

Intellectual property and authorship disputes are another emerging concern. Policies such as those from the University of Oxford advise researchers to consider intellectual property, confidentiality, and terms of service when using third-party AI tools, particularly where

sensitive or funder-owned data are involved (University of Oxford, 2023). This highlights that responsible AI use also requires legal and contractual awareness.

Across the sector, there is a clear move toward normalising openness about AI. Vitae is signalling greater emphasis on digital competence and ethical AI use within researcher development frameworks, while funders such as UKRI increasingly expect transparency around AI assistance in grant writing and research processes (Vitae, 2023; UKRI, 2024). Universities including Imperial College London and King's College London have articulated high-level principles centred on transparency, human oversight, and responsibility to guide doctoral researchers' use of AI (Imperial College London, 2023; King's College London, 2023).

In summary, this theme shows that challenges related to authorship, identity, and integrity are being actively managed rather than ignored. Universities have moved quickly to clarify that AI cannot be an author, that human researchers remain accountable, and that transparency is central to ethical scholarship. Through policies, pedagogy, and supervision, institutions are working to protect the formation of doctoral researchers as original, ethical thinkers, even as research practices become increasingly AI-augmented. This sets the foundation for the final theme, which focuses on building the competencies and institutional frameworks needed for responsible AI integration in doctoral education.

3.6. Developing Digital Literacy and AI Competencies in Researchers

The final theme highlights how universities are moving beyond tools and policies to focus on building skills, awareness, and inclusive practices that enable doctoral researchers to use AI responsibly and confidently. Across institutions, there is a shared recognition that access to AI alone is insufficient; researchers must develop AI literacy, ethical judgement, and the capacity to adapt as technologies evolve. This aligns closely with established frameworks in digital literacy, professional development, and critical pedagogy (Vitae, 2023; Selwyn, 2024).

Across our cases, AI literacy is consistently framed as a combination of knowledge, skills, and attitudes. A prominent example is the University of Manchester's collaboration with UNESCO on developing AI competency frameworks for students and educators. These frameworks aim to define what learners should understand about AI fundamentals, ethical use, data privacy, bias, and critical evaluation of outputs (UNESCO, 2024). Universities are expected to map such competencies onto their researcher development provision, for example by embedding case studies on bias or reflective exercises on evaluating AI-generated results within doctoral training.

In the UK context, digital and AI-related competencies are increasingly connected to the Vitae Researcher Development Framework (RDF). While the RDF has long included digital literacy, current revisions signal a stronger emphasis on AI and digital scholarship as core research skills rather than optional extras (Vitae, 2023). At institutional level, universities such as University College London and the University of Edinburgh have developed online resources and "Generative AI hubs" that introduce researchers to AI tools alongside guidance on ethical and transparent use (UCL, 2023; University of Edinburgh, 2023). The emphasis is not on banning AI, but on fostering informed and reflective engagement.

Formal training initiatives further support this literacy agenda. Many universities now incorporate AI-focused sessions into doctoral professional development programmes, covering practical uses, limitations, and ethical considerations. Workshops such as "Generative AI and the Researcher" or institution-wide events like "Accelerating Research with AI" at the University of Cambridge illustrate how peer learning and shared practice are being used to normalise responsible experimentation (University of Cambridge, 2023). Hands-on formats, including hackathons and guided pilot projects, allow doctoral researchers to explore AI applications within safe and supported environments.

Ethical training is a central pillar of these efforts. Universities increasingly integrate AI into existing research ethics education, using scenario-based approaches to prompt critical thinking. For example, doctoral researchers may be asked to consider how to respond when AI outputs contradict established literature, or how to ensure fairness and inclusivity when AI tools are unevenly accessible across research teams (QAA, 2023). Projects such as King's College London's work on ethical and equitable use of generative AI demonstrate how ethics, pedagogy, and inclusion are being addressed together (King's College London, 2023).

Inclusivity emerges as a key concern in building AI capability. While AI can support groups such as non-native English speakers or researchers with disabilities, it also risks reinforcing digital divides if access and training are uneven. Institutions are responding by offering institutional licences, secure platforms, and accessible training rather than assuming prior technical expertise. The values-oriented approach promoted in UNESCO's frameworks emphasising equity, responsibility, and openness alongside skills resonates strongly with these institutional strategies (UNESCO, 2024).

Rather than treating AI literacy as a one-off intervention, universities are increasingly embedding it across the doctoral journey. This includes induction sessions, thesis writing courses, optional micro-credentials, and specialist pathways for data-intensive research. The aim is to establish a baseline level of AI competence for all doctoral researchers, while allowing deeper engagement where disciplinary needs demand it (Vitae, 2023).

At an institutional level, these initiatives are often brought together within broader responsible AI integration frameworks. Such frameworks typically combine infrastructure provision, training, policy guidance, and ongoing evaluation, often developed collaboratively across academic, professional, and student communities. Examples from institutions aligning with Jisc guidance suggest a strategic "embrace and adapt" approach rather than reactive regulation (Jisc, 2023).

Crucially, universities are also fostering communities of practice and feedback loops. Reflective spaces, focus groups, and pilot programmes such as those reported at Manchester and King's College London enable doctoral researchers and supervisors to shape AI guidance iteratively based on lived experience (University of Manchester, 2023; King's College London, 2023). This participatory approach reflects a critical pedagogy ethos, positioning researchers not just as recipients of policy but as contributors to ethical AI practice. Table 2 provides a thematic overview of the cross-case findings and illustrates how each theme manifested across institutional contexts.

Finally, continuous learning is framed as a core competency. Given the rapid pace of AI development, universities emphasise the ability to evaluate new tools, seek reliable guidance, and reflect critically on emerging practices. Sector bodies such as Vitae and Jisc play an important role in supporting this culture through events, resources, and shared case studies (Vitae, 2023; Jisc, 2023).

In summary, this final theme demonstrates a proactive and educative institutional response to AI in doctoral education. Universities are investing in literacy, ethics, inclusivity, and adaptability, recognising that responsible AI integration is ultimately about people rather than tools. By equipping doctoral researchers with the skills and critical awareness to navigate AI thoughtfully, institutions are preparing them not only for current research demands, but for continued digital transformation in academia. This provides a strong foundation for the Discussion, where these findings can be interpreted through theoretical lenses such as digital literacy, ethical AI, critical pedagogy, and professional identity development.

Table 2. Cross-Case Thematic Overview

Theme	Description	Example Evidence	Cross-Case Pattern
Institutional Strategies & Governance	Formal or emerging AI governance structures in doctoral contexts	Institutional AI policies; integrity frameworks	Present in all institutions, but depth and specificity vary
AI Tools for Academic Writing	Guidance on generative AI use in writing and literature review	Writing support workshops; disclosure guidance	Common focus area, especially in doctoral skills training
AI in Research Workflows	Use of AI in data analysis, coding, and research design	Research methods training; digital scholarship resources	Stronger emphasis in technically oriented institutions
Evolving Supervision Practices	Adjustments in supervisory guidance regarding AI use	Supervisor briefings; policy references to supervision	Emerging area with limited formal guidance
Challenges: Authorship & Identity	Concerns about originality, authorship, and academic integrity	Integrity statements; ethical AI framing	Prominent across institutions, often framed cautiously
Developing AI & Digital Literacy	Training aimed at building responsible AI competence	Doctoral training workshops; digital skills initiatives	Increasing priority but uneven institutional coverage

4. Discussion

The thematic findings above illustrate a doctoral training landscape in flux – one that is actively negotiating the integration of AI and digital technologies into its core. In this Discussion, we interpret these findings through the lens of the theoretical frameworks introduced earlier and consider the implications for researcher development practice and policy. We also examine how the UK case, though our focus, resonates with international trends, potentially offering lessons beyond the local context. The discussion is organized around four intersecting dimensions: digital literacy and skills development, ethical AI usage (including policy alignment), critical pedagogy and inclusion, and the evolving professional identity of researchers. We then synthesize these to propose elements of a strategic framework for responsible AI integration.

Figure 3 presents a strategic framework for the responsible integration of artificial intelligence in doctoral education. The framework synthesises the cross-case findings and highlights six interconnected areas that institutions must address: governance, training, supervision, ethics, infrastructure, and inclusion. Rather than treating AI as a purely technical issue, the framework positions AI integration as a pedagogical, ethical, and institutional development process.

At the foundation of the framework is institutional governance, which establishes clear policies on responsible and transparent AI use. Building on this, doctoral training provision develops

researchers' AI literacy and critical digital skills. Figure 2 presents a strategic framework for the responsible integration of artificial intelligence in doctoral education.
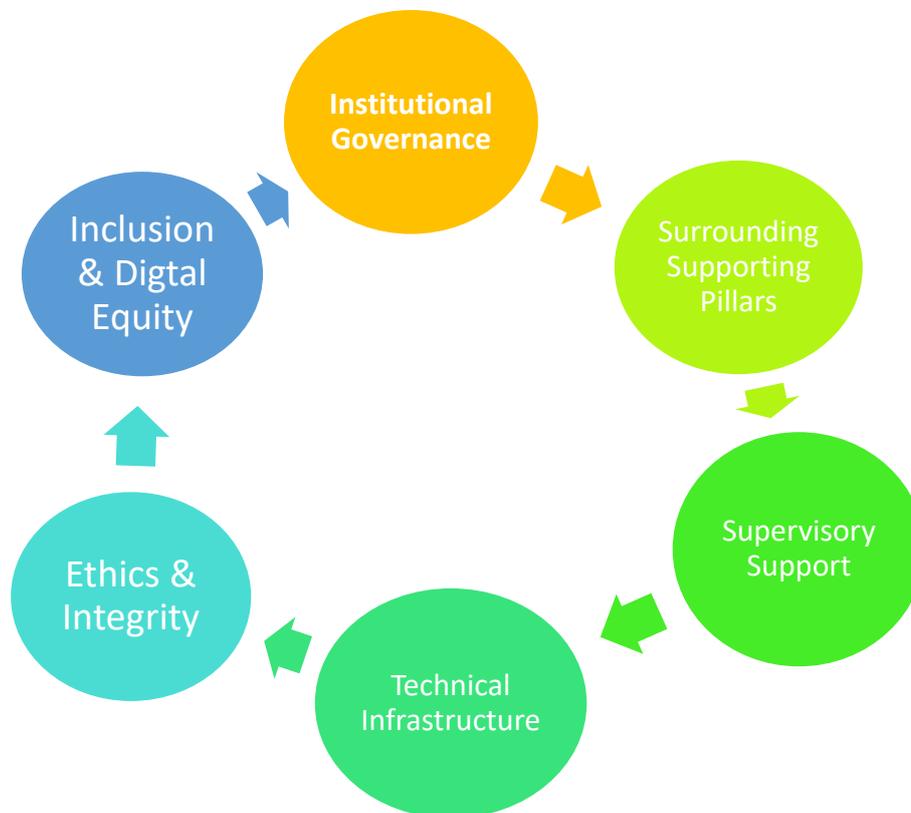

Figure 2. Strategic framework for AI in doctoral education

The framework synthesises the cross-case findings and highlights six interconnected areas that institutions must address: governance, training, supervision, ethics, infrastructure, and inclusion. Rather than treating AI as a purely technical issue, the framework positions AI integration as a pedagogical, ethical, and institutional development process. Institutional governance establishes clear expectations for responsible AI use. Doctoral training provision develops AI literacy and critical digital skills. Supervisory support ensures expectations around AI use are negotiated within research relationships. Ethical and integrity guidance safeguards authorship norms and research credibility. Technical infrastructure provides secure and equitable access to AI tools, while inclusion and digital equity considerations address disparities in skills and access among doctoral researchers.

4.1.   Digital Literacy as a Foundation for AI-Integrated Research

Our analysis shows that digital literacy specifically AI literacy has become a foundational element of contemporary researcher development, rather than an optional add-on. In higher

education, digital literacy extends beyond technical proficiency to include understanding the affordances and limitations of digital tools, and the ability to critically evaluate digital outputs and practices (Selwyn, 2019; Hargittai, 2010). Recent scholarship frames this as critical digital literacy or critical AI literacy, emphasising awareness of the social, ethical, and epistemic contexts in which AI operates, not merely its functionality (Selwyn, 2024).

Across our case studies, UK universities demonstrate a tacit adoption of this critical literacy approach. Initiatives such as AI hubs, targeted workshops, and revisions to researcher development competencies reflect an emphasis on principles rather than tools for example, understanding how generative AI systems work, recognising bias in training data, and appreciating the probabilistic nature of text generation (Vitae, 2023). This aligns with Shulman's notion of adaptive expertise, where the goal of education is not mastery of fixed techniques, but the capacity to continually learn and adapt as tools evolve (Shulman, 2005).

A notable insight from our analysis is that doctoral researchers themselves are often drivers of AI learning, particularly through peer-to-peer exchange and informal experimentation. Universities are increasingly recognising and supporting this by creating spaces for shared reflection and dialogue. For instance, initiatives at the University of Manchester that provide non-judgmental environments for discussing AI use resonate strongly with situated learning theory, which emphasises learning through participation in communities of practice (Lave & Wenger, 1991). Such approaches complement formal training by embedding AI learning within real research contexts.

From a skills framework perspective, the UK's approach offers a useful model. Forthcoming AI competency frameworks from UNESCO are expected to outline broad competencies applicable across educational levels, including ethical awareness, critical evaluation, and responsible use (UNESCO, 2024). Our findings suggest that doctoral education requires additional, research-specific competencies, such as using AI for knowledge discovery, maintaining research integrity when using AI, and applying AI creatively within disciplinary norms. These competencies map closely onto domains within the Vitae Researcher Development Framework, particularly "Knowledge and Intellectual Abilities" and "Research Governance" (Vitae, 2023).

Sector-level engagement reinforces this shift. The involvement of bodies such as UK Council for Graduate Education in AI-focused PGR events indicates growing consensus that AI literacy is now part of what it means to be a competent researcher much as statistical and computational

literacy became essential in earlier decades (UKCGE, 2023). It is plausible that, in the near future, academic and research job descriptions will explicitly reference the ability to use digital and AI tools in research and teaching.

However, our analysis also highlights equity challenges. While well-resourced institutions are integrating AI literacy rapidly, smaller institutions or certain disciplines particularly in the arts and humanities may have less access to training and infrastructure. These risks creating uneven development across the sector. National bodies such as UK Research and Innovation and the Quality Assurance Agency therefore have an important role in supporting scalable, adaptable resources (QAA, 2023). Initiatives like AI.RDN+ and guidance from Jisc are well positioned to reduce disparities by sharing case studies, toolkits, and open resources across institutions (Jisc, 2023).

In summary, AI literacy emerges as a cornerstone of reimagined doctoral training in the UK context. Universities are moving away from treating digital skills as peripheral and toward embedding them as core learning outcomes of the PhD. This shift supports long-standing arguments that digital capability constitutes a form of power in knowledge production (Hargittai, 2010). By equipping doctoral researchers with critical, ethical, and adaptive AI literacies, institutions are strengthening both research integrity and long-term research innovation.

4.2.   Aligning with Ethical AI Principles and Policy: Balancing Innovation and Integrity

The ethical challenges and policy responses identified in our findings show a strong practical alignment with established ethical AI frameworks. At a global level, principles such as transparency, accountability, fairness, and human oversight are articulated in documents including the UNESCO *Recommendation on the Ethics of Artificial Intelligence* (2021) and the European Union's Draft AI Act (European Commission, 2023). Within the academic context, these same principles are clearly visible: transparency through the disclosure of AI use, accountability through the prohibition of AI authorship and insistence on human responsibility, and fairness through attention to bias, access, and the risk of disadvantaging underrepresented groups.

University-level policies across the UK reflect this ethical orientation. Institutions such as the University of Oxford, King's College London, and University of Cambridge have adopted approaches that neither ban AI outright nor permit unrestricted use. Instead, they promote

responsible innovation, an approach Oxford Brookes describes as "embrace and adapt," aligned with guidance from Jisc (Jisc, 2023). This mirrors recommendations from AI ethicists who argue that the goal should be to enable beneficial uses of AI while embedding safeguards against misuse (Floridi et al., 2018).

Sector-level guidance reinforces this coherence. Advice from the Quality Assurance Agency encourages institutions to update misconduct policies, rethink assessment design, and educate students about ethical AI use rather than relying on prohibition or surveillance (QAA, 2023). The consistency across UK universities such as the universal rejection of AI authorship and widespread requirements for disclosure suggests effective knowledge-sharing and coordination, facilitated by bodies including UK Council for Graduate Education and Research England–funded initiatives (UKCGE, 2023).

A key question is whether regulation risks stifling innovation. Our analysis suggests that, so far, UK policies are permissive with conditions rather than restrictive. For example, Oxford's generative AI policy explicitly frames its purpose as enabling safe and creative use, particularly important in doctoral research where methodological experimentation and boundary-pushing are central (University of Oxford, 2023). Importantly, several institutions involved researchers directly in policy development, helping ensure that guidelines preserve necessary flexibility. Oxford's decision to publish and archive its policy openly, encouraging reuse and adaptation, reflects a governance model aligned with academic values of openness and collaboration.

These institutional policies also align with national research policy developments. UK Research and Innovation now expects transparency about AI use in grant applications, reinforcing the norms being taught to doctoral researchers (UKRI, 2024). Similarly, the UK Department for Education's consultation on AI, to which QAA contributed, points toward a coordinated national approach that emphasises education, integrity, and human judgement over blanket bans (DfE, 2023; QAA, 2023). In this sense, doctoral training functions as early socialisation into the ethical expectations researchers will face throughout their careers.

Internationally, the UK's approach is likely to attract attention. In the United States, institutions such as MIT and Harvard University initially adopted restrictive stances on generative AI, before moving toward more nuanced, ethics-driven guidance (MIT, 2023; Harvard University, 2023). By contrast, UK universities largely converged on guidance relatively early, positioning the sector as a potential model. The involvement of the University of Manchester in UNESCO's

AI competency work further ensures that UK experiences in doctoral education inform global discussions (UNESCO, 2024).

A remaining challenge concerns monitoring and trust. Early evidence suggests that some students underreport minor AI use, either because they perceive it as insignificant or fear negative consequences (Bretag et al., 2023). Addressing this requires shifting from a punitive framing of integrity toward a developmental one. Encouraging openness, modelling transparency, and treating doctoral researchers as partners in ethical practice align closely with principles of critical pedagogy and are more likely to foster trust and compliance over time.

At a deeper level, these ethical discussions raise questions about the legitimacy of AI-assisted knowledge production. The emerging consensus is that AI assistance does not diminish scholarly contribution, provided the researcher retains intellectual control and clearly articulates their role. Policies such as UCL's requirement for detailed AI-use declarations encourage researchers to reflect on how AI shaped their work, reinforcing rather than undermining scholarly identity (UCL, 2023). In this sense, ethical compliance can itself become a reflective scholarly practice.

In conclusion, the UK's doctoral training landscape demonstrates strong synergy between ethical AI principles and everyday research practice. Universities are using policies not merely as guardrails, but as educational tools that promote transparency, responsibility, and reflexivity. As AI capabilities continue to expand potentially influencing research design, interpretation, and theory-building these ethical frameworks will require ongoing revision and dialogue. Maintaining this reflective, community-driven approach will be essential if universities are to uphold integrity while enabling innovation in an increasingly AI-mediated research environment.

4.3. Critical Pedagogy and Inclusion: Ensuring Empowerment in AI Adoption

Viewed through the lens of critical pedagogy, the integration of AI into researcher development raises fundamental questions about power, agency, and equity in doctoral education. Rooted in the work of Paulo Freire, critical pedagogy asks whether educational practices empower learners to question, reflect, and shape their learning conditions, or whether they risk reproducing passivity, dependency, or surveillance (Freire, 1970). Applied to AI, the key question becomes: does AI enhance doctoral researchers' agency, or does it subtly displace their intellectual labour and voice?

Our findings suggest that UK universities are making deliberate efforts to keep doctoral education human-centred, positioning AI as an enabling tool rather than a substitute for scholarly judgement. For example, empirical work from Chalmers University of Technology demonstrates an explicitly pedagogical approach to AI use in academic writing, emphasising peer interaction, feedback-seeking, and reflective engagement rather than automated text production (Hosseini et al., 2023). This model frames AI use as a triadic interaction between student, AI, and supervisor or peers requiring critical evaluation and disciplinary awareness. Such practices align closely with Freirean principles, which emphasise dialogue, reflection, and learner agency over passive consumption.

From an inclusion perspective, AI presents a productive tension. On one hand, AI tools can lower barriers for non-native English speakers and researchers with disabilities, supporting linguistic clarity or accessibility. On the other, AI systems can reproduce structural biases embedded in their training data, potentially marginalising voices from underrepresented traditions or regions. UK institutional guidance reflects an awareness of this duality. By allowing AI use for language support rather than banning it outright, universities such as University College London and King's College London avoid disproportionately disadvantaging students who may benefit most from AI assistance (UCL, 2023; King's College London, 2023). This stance resonates with critical pedagogy's concern for equity and access.

At the same time, critical pedagogy requires attention to epistemic bias. AI tools trained predominantly on Western or mainstream academic corpora may marginalise alternative epistemologies or Global South scholarship. A critically informed doctoral education would therefore not only teach students how to use AI, but also how to interrogate its silences and biases for example, by examining which voices are omitted in AI-generated literature summaries. This connects directly to debates on decolonising knowledge and epistemic justice, which are increasingly present in UK higher education discourse (Bhambra et al., 2018; Selwyn, 2024).

The pedagogical principle articulated in UCL's guidance that AI use must not substitute for the researcher's own development is particularly significant from a critical pedagogy perspective. It foregrounds learning as transformation, not mere output production, echoing Freire's concept of *conscientização* (critical consciousness). The emphasis is on ensuring that AI does not short-circuit the formative struggle through which doctoral researchers develop independence,

judgement, and confidence. In practice, this may involve staged or reflective use of AI: learning a method manually before using AI to scale or extend analysis.

Power dynamics within supervision are also reshaped by AI. Differences in digital confidence between supervisors and students can alter traditional hierarchies, potentially creating new forms of dependency or tension. Institutional guidance encouraging open discussion and mutual agreement on AI use such as scenarios outlined by King's College London and advice from the University of Cambridge supports a dialogic supervisory relationship, consistent with critical pedagogy's emphasis on co-learning and negotiated authority (University of Cambridge, 2023).

A further concern raised by critical pedagogy is the instrumentalisation of education. AI risks being adopted primarily to increase efficiency, outputs, or competitiveness, rather than to deepen intellectual inquiry. Our analysis suggests that UK universities generally frame AI in terms of enhancing research quality, creativity, and researcher wellbeing, rather than as a productivity shortcut (QAA, 2023). Nonetheless, critical pedagogy cautions that this balance must be actively maintained, particularly in an increasingly marketised higher education context.

Importantly, the process of policymaking itself reflects critical pedagogical values when it is participatory. UK universities have often involved students, supervisors, and professional staff in developing AI guidance through consultations, roundtables, or surveys thereby reducing hierarchical distance and recognising doctoral researchers as stakeholders rather than passive subjects (UKCGE, 2023). Such inclusion strengthens legitimacy and aligns policy with lived experience.

In sum, viewed through a critical pedagogy lens, the UK's approach to AI in doctoral education appears cautiously optimistic. Institutions are largely striving to integrate AI in ways that support dialogue, inclusion, and researcher agency, while remaining alert to risks of bias, dependency, and instrumentalisation. Critical pedagogy reminds us that this integration must remain an ongoing praxis combining reflection and action as AI continues to evolve. There is clear scope to deepen this approach further, for example by involving doctoral researchers in co-designing AI training or critically studying AI's impact within their own disciplines. AI integration, in this sense, is not a finished policy project but a continuing educational journey.

4.4. Evolving Researcher Identity and Professionalism in the Digital Age

The changes identified in our analysis have significant implications for the professional identity development of doctoral researchers. Doctoral education is not only a process of acquiring knowledge and skills, but also a process of *becoming* forming an identity as an independent, confident member of the scholarly community (McAlpine & Amundsen, 2011). The increasing presence of AI in research therefore raises fundamental identity questions: how autonomy, creativity, and expertise are understood when intelligent tools can perform tasks once seen as markers of scholarly competence.

Our findings suggest that researcher identity is not being eroded, but rather reframed. Proficiency with AI is increasingly positioned as part of what it means to be a competent researcher, much as earlier generations had to integrate statistical software or computational methods into their scholarly practice (Bennett, 2018). Institutional narratives consistently emphasise that AI does not replace researchers, but augments them. This framing positions doctoral researchers as AI-augmented experts those who design questions, make interpretive judgements, and take responsibility for outcomes, known in the literature as *human-in-the-loop* knowledge production (Floridi et al., 2018).

Policies at institutions such as University College London and the University of Oxford reinforce this identity shift by requiring doctoral researchers to explicitly explain how AI was used and what intellectual work remained human (UCL, 2023; University of Oxford, 2023). This requirement encourages reflexivity and helps researchers articulate their own scholarly contribution often strengthening rather than weakening professional confidence. By distinguishing between *assistance* and *authorship*, these policies reaffirm that creativity, synthesis, and judgement remain human responsibilities.

At the same time, our analysis recognises the emotional and psychological dimensions of identity formation. Some doctoral researchers may experience doubt or impostor feelings when AI has played a substantial role in drafting, analysis, or organisation (Parkman, 2016). Institutional and supervisory messaging therefore matters greatly. Framing AI as analogous to sophisticated research instruments rather than as a shortcut or substitute helps normalise its use without undermining self-worth. Just as a scientist does not feel less of a scientist for using advanced sequencing technology, a historian or social scientist should not feel less legitimate for using AI-based analytical tools.

Professional identity is also closely tied to authorship and accountability. The universal stance that AI cannot be listed as an author, adopted by publishers and reinforced by universities, asserts the primacy of human responsibility in scholarship (Nature, 2023; Science, 2023). This clarity helps preserve ownership and motivation: achievements and errors alike belong to the researcher. At the same time, identity subtly expands to include being a *skilful manager of intelligent tools*. Seeing oneself as competent now includes the ability to select, evaluate, and ethically deploy AI an expectation likely to be formalised further through updates to frameworks such as the Vitae Researcher Development Framework (Vitae, 2023).

These identity shifts are not limited to doctoral researchers. Supervisors and examiners are also renegotiating their professional roles, moving from sole knowledge authorities toward facilitators of ethical, reflective AI use. Guidance from institutions such as King's College London explicitly addresses examiner and supervisory responsibilities in relation to AI transparency, indicating that digital oversight is becoming part of academic professionalism (King's College London, 2023). This evolution supports a more dialogic supervision model, where expertise flows in both directions.

However, identity formation is shaped not only by tools, but by research culture. A potential risk is that AI-driven efficiency could reinforce productivity pressures, encouraging doctoral researchers to equate worth with output volume. UK discourse around research culture reflected in the Researcher Development Concordat and Wellcome Trust initiatives acts as a counterbalance, emphasising quality, wellbeing, and sustainability (UKRI, 2022). Used thoughtfully, AI can free time for deeper thinking, creativity, and balance, contributing to a healthier researcher identity rather than intensifying burnout.

At a deeper philosophical level, AI challenges traditional ideas of discovery and knowledge production. If an AI system identifies a pattern invisible to human perception, the prevailing academic consensus still attributes discovery to the researcher who framed the question and interpreted the result. UK policy firmly maintains this position, reinforcing the human researcher as the primary epistemic agent (Floridi, 2019). This stance stabilises identity at a time of rapid technological change.

In summary, doctoral researcher identity in the AI-augmented landscape is evolving rather than diminishing. Being a professional researcher now increasingly means being digitally fluent, ethically grounded, reflective, and critically autonomous. UK universities are actively shaping

this transition through policy, training, and supervision, aiming to ensure that autonomy, creativity, and responsibility remain at the core of scholarly identity. While the long-term effects will require longitudinal study, our analysis suggests that future researchers are likely to see AI as a routine part of their scholarly persona while continuing to take pride in the uniquely human dimensions of research: insight, theory-building, ethical judgement, and intellectual courage.

4.5. Toward a Strategic Framework for Responsible and Inclusive AI Integration

Bringing together insights across policy, pedagogy, ethics, and identity, our analysis points to the need for a coherent strategic framework to support the responsible and inclusive integration of AI into researcher development. Case studies from UK universities provide concrete practices, while the theoretical discussion offers a strong rationale grounded in digital literacy, ethical AI, critical pedagogy, and professional identity development (Holmes et al., 2023; Selwyn, 2024). Rather than ad hoc responses, institutions benefit from a joined-up approach that treats AI as part of the research ecosystem.

4.5.1. *Policy and Guidelines*

Institutions should establish clear, evolving policies that enable ethical AI use while safeguarding core scholarly responsibilities. Key elements include mandatory disclosure of AI assistance, explicit rejection of AI authorship, and alignment with national and international standards (UKRI, QAA, UNESCO). Collaborative policy development with students, supervisors, and professional staff supports legitimacy and adaptability. Institutional examples such as the University of Oxford's generative AI policy and King's College London's doctoral guidance illustrate clarity of scope and intent (University of Oxford, 2023; King's College London, 2023).

4.5.2. *Infrastructure and Access*

Responsible AI integration depends on secure and equitable access. Universities should provide institutionally supported platforms that protect data privacy and intellectual property, alongside a range of licensed tools suited to different disciplines. The University of Edinburgh's ELM platform exemplifies safe experimentation, while institution-wide approaches such as "One Leeds" and UCL's education-focused AI partnerships demonstrate efforts to democratise access (University of Edinburgh, 2023; UCL, 2023). This pillar directly addresses inclusion by reducing reliance on personal resources.

4.5.3. *Skills Development and Training*

AI literacy should be embedded across doctoral training, not treated as an optional add-on. Effective provision combines formal workshops, online modules, one-to-one support, and peer learning, covering both technical use and ethical, strategic judgement (Vitae, 2023). Aligning this provision with recognised frameworks (e.g., the Vitae Researcher Development Framework) institutionalises AI competence. Initiatives led by the University of Manchester and sector bodies such as UKCGE emphasise competencies, reflection, and adaptability (UKCGE, 2023).

4.5.4. *Ethical Oversight and Research Culture*

Beyond rules, universities must cultivate a culture of ethical AI use. This includes integrating AI scenarios into research integrity training, offering advisory panels for complex cases, and publicly recognising responsible AI-enhanced research. Open forums such as Manchester's library-based dialogue spaces normalise ethical reflection as part of everyday research practice (QAA, 2023). Rapid institutional responses to generative AI's emergence in 2023 indicate active culture-building rather than reactive policing.

4.5.5. *Supervision and Mentorship Adaptation*

Supervisors require targeted support to guide students' AI use confidently and fairly. This includes supervisor development programmes, practical guidance (e.g., "AI in supervision" toolkits), and encouragement of early, transparent conversations about boundaries and expectations. Projects exploring future supervision models, alongside scenario-based guidance at institutions like KCL, demonstrate how supervision can evolve while remaining dialogic and developmental (UKCGE, 2023).

4.5.6. *Continuous Feedback and Evolution*

Given the pace of technological change, AI strategies must be iterative. Institutions should gather evidence through surveys of PGRs and supervisors, analysis of AI declarations, and monitoring of integrity cases, while tracking emerging tools. Networks such as AI.RDN+ are well positioned to coordinate sector-wide learning and evaluate outcomes (e.g., impacts on writing quality or time-to-completion). Continuous review ensures responsiveness rather than rigidity.

4.5.7. *Inclusivity and Global Perspective*

Finally, responsible AI integration must foreground equity and global engagement. Frameworks should account for diverse needs (international students, disabled researchers, disciplinary epistemologies) and engage with international initiatives and standards. Manchester's focus on marginalised learners and UCL's global education partnerships reflect this outward-looking orientation (UNESCO, 2021; UNESCO, 2024). Regular inclusivity checks reviewing tools, examples, and training content help operationalise this commitment.

This study has several limitations. The analysis was based exclusively on publicly available institutional documents, which may not fully capture informal practices or internal decision-making processes. Institutional AI policies are also evolving rapidly, meaning the findings represent a snapshot of practice during the data collection period. While cross-case comparison enables analytical insight, the findings are not intended to be statistically generalisable beyond similar research-intensive contexts.

5. Conclusion

Artificial intelligence and digital technologies are rapidly reshaping the landscape of doctoral education. This study set out to examine how these tools are transforming postgraduate researcher (PGR) development and supervision across the UK, drawing on qualitative insights from multiple universities. Our findings reveal a sector undergoing constructive and reflective change: universities are experimenting, learning, and institutionalising new practices that integrate AI in ways that enhance doctoral education while safeguarding its core academic values.

Across institutions such as University College London, University of Oxford, University of Cambridge, University of Manchester, University of Edinburgh, and King's College London, a shared trajectory is evident. Initial uncertainty and concern about AI's implications have largely given way to a pragmatic, ethically grounded embrace, commonly framed around "responsible use with human oversight." Universities have moved swiftly to establish guidance that clarifies acceptable uses of generative AI in writing, data analysis, and research workflows, consistently emphasising transparency, accountability, and academic integrity (QAA, 2023).

A central conclusion of this study is that AI can meaningfully support researcher development when used critically and transparently. Across our cases, AI tools were shown to assist literature reviewing, improve academic writing, accelerate data analysis, and facilitate remote and

collaborative supervision. Doctoral researchers reported using generative tools for brainstorming and language refinement, specialist AI software for handling complex datasets, and digitally enhanced platforms to maintain supervisory relationships across distance. These practices can save time on routine tasks, open new analytical possibilities, and in some cases improve the clarity and accessibility of research outputs (Hosseini et al., 2023). Crucially, when AI is framed as an assistive tool rather than a substitute for scholarly judgement, it can free researchers to focus more on higher-order thinking, creativity, and interpretation.

At the same time, our analysis underscores that such benefits are not automatic. Risks to authorship, authenticity, and research integrity are real and persistent. Documented issues such as fabricated references, analytical errors, or over-reliance on automated outputs highlight the importance of robust safeguards. The institutional responses we observed mandatory disclosure of AI use, explicit rejection of AI authorship, strengthened integrity training, and reinforcement of human accountability are therefore essential. These measures do more than protect research credibility; they protect the formative integrity of doctoral education itself, ensuring that the PhD remains a process of intellectual growth rather than delegated labour.

Another important conclusion is the role of theoretical frameworks in shaping effective practice. Universities that approached AI integration through lenses such as digital and AI literacy, ethical AI, and critical pedagogy were better positioned to design sustainable researcher development provision. Rather than training students in transient tools, institutions focused on cultivating adaptable, critical capacities enabling researchers to evaluate, question, and responsibly use evolving technologies (Selwyn, 2024). Similarly, critical pedagogical approaches emphasising dialogue, reflection, and agency helped ensure that AI use amplified rather than diminished doctoral researchers' sense of ownership and scholarly identity (Freire, 1970).

Our comparative analysis also highlighted exemplary practices with wider relevance. The AI.RDN+ network illustrates the value of sector-wide collaboration in producing shared guidance and evidence. Secure institutional platforms, such as Edinburgh's ELM, demonstrate how access and data protection can be addressed simultaneously. Innovative hybrid roles and programmes such as UCL's AI-focused research and education initiatives show how AI development can be embedded directly into researcher training. Meanwhile, clear and principled guidance documents from Oxford and King's provide adaptable templates for institutions both within and beyond the UK.

At a policy level, we observed strong alignment between institutional practice and national and international frameworks, including those from UK Research and Innovation, the Quality Assurance Agency, Vitae, and UNESCO. This multi-level coherence matters: doctoral researchers receive consistent messages about ethical AI use from their universities, funders, and the wider academic ecosystem. As AI continues to evolve, maintaining this alignment through dialogue, consultation, and shared learning will be vital.

Drawing these insights together, the strategic framework proposed in the Discussion offers a practical roadmap for institutions seeking to reimagine doctoral education in the digital age. By integrating policy, infrastructure, skills development, ethics, supervision, feedback, and inclusivity into a single approach, universities can move beyond reactive measures toward a resilient and future-ready model of researcher development.

In closing, we return to the fundamental purpose of doctoral education: to cultivate researchers capable of advancing knowledge through independent, critical, and ethical inquiry. The UK experience demonstrates that embracing AI and digital innovation need not dilute this purpose. On the contrary, when thoughtfully integrated, AI can accentuate what is most human in scholarship creativity, judgement, interpretation, and responsibility while alleviating unnecessary drudgery. The doctorate in the digital age thus remains, at its best, a journey toward intellectual independence, now undertaken with new digital companions and unfamiliar terrain, but guided by enduring scholarly values and the same summit in sight: the creation of new knowledge by reflective, capable, and ethical researchers.

Recommendations for Policy, Practice, and Future Research

Building on the findings of this study, several implications emerge for universities and for ongoing scholarly inquiry:

- **Establish coherent, regularly updated institutional AI frameworks** that integrate governance, research integrity, doctoral training, and supervision guidance into a unified strategy rather than isolated policy statements.
- **Embed critical AI literacy across the doctoral lifecycle**, ensuring that researchers develop not only operational familiarity with tools but also the capacity to evaluate limitations, ethical risks, and epistemological implications of AI in knowledge production.

- **Invest in supervisor development and support structures**, enabling supervisors to engage confidently with AI-related questions, negotiate expectations with doctoral researchers, and model reflective, responsible digital scholarship.

- **Ensure equitable and secure access to AI infrastructure**, including institutionally supported tools, data protection safeguards, and targeted support for researchers who may face digital skill or resource gaps.

- **Future research should move beyond policy analysis to examine lived doctoral experiences**, exploring how AI integration shapes research practices, supervisory relationships, disciplinary differences, and long-term researcher identity formation.

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