



GENERATIVE AI AS AN INFORMING RESOURCE FOR DOCTORAL RESEARCH IN BOTSWANA: OPPORTUNITIES, CHALLENGES, AND GOVERNANCE NEEDS

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ABSTRACT

Aim/Purpose	Doctoral students increasingly use Generative Artificial Intelligence (GenAI) as an informing resource, but its benefits, challenges, and governance requirements remain underexplored in developing-country contexts such as Botswana. This study examines GenAI's contribution to doctoral research and the institutional measures needed for its ethical and effective integration.
Background	GenAI has become a prominent feature of higher education and doctoral research, supplementing traditional academic and supervisory support within an emerging informing system in which students receive, evaluate, verify, and act upon information from digital tools, supervisors, and institutional guidance. The effectiveness of this system depends on information quality, critical judgment, supervisory practices, equitable access, and institutional governance, particularly in developing-country contexts such as Botswana, where digital and institutional capacity may be uneven.
Methodology	This study adopted an exploratory qualitative design and used semi-structured interviews to investigate doctoral students' experiences of GenAI use in research. Guided by the Informing Science perspective, the study examined how doctoral students receive, evaluate, verify, and act upon information provided through GenAI tools and related institutional channels. The sample comprised

Accepting Editor Louise Underdahl | Received: April 27, 2026 | Revised: July 15, 2026 |

Accepted: July 23, 2026.

Cite as: Zlotnikova, I., Mokgetse, T. L., & Hlomani, H. (2026). Generative AI as an informing resource for doctoral research in Botswana: Opportunities, challenges, and governance needs. *International Journal of Doctoral Studies*, 21, Article 11. <https://doi.org/10.28945/5858>

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	15 doctoral students from science and engineering disciplines at one university in Botswana, and the data were analyzed using qualitative thematic analysis.
Contribution	This paper contributes to the body of knowledge by providing empirical evidence on how doctoral students in Botswana use GenAI as an informing resource in their research, the challenges they encounter, and the forms of policy and institutional support they consider necessary for responsible use. It extends a literature base dominated by Global North contexts by offering a developing-country perspective and by applying the Informing Science perspective to doctoral GenAI use. The paper shows that GenAI in doctoral education should be understood not only as a productivity tool, but also as part of an emerging doctoral informing system shaped by information quality, verification, scholarly development, equity, and governance.
Findings	The study found that doctoral students in Botswana used GenAI as an informing resource mainly for idea development, literature review support, proofreading and language refinement, methodological clarification, and, to a lesser extent, data analysis and programming support. ChatGPT was the most frequently reported tool. Participants also identified major challenges to effective GenAI-based informing, especially reliability and accuracy of outputs, overreliance, verification and traceability, policy uncertainty, financial and access barriers, contextual mismatch and bias, and privacy and security concerns. They emphasized the need for responsibility and integrity, clear boundaries of acceptable use, integration into existing governance, declaration and transparency, policy enforcement, structured educational integration, and training for students and supervisors.
Recommendations for Practitioners	Universities and doctoral supervisors should provide clear, context-sensitive guidance on acceptable GenAI use as part of a responsible doctoral informing system. This guidance should address disclosure, verification, privacy, academic integrity, and human accountability for research outputs. Institutions should also strengthen effective GenAI-based informing through workshops, practical training, supervisor-student dialogue, and equitable access to relevant tools and digital infrastructure.
Recommendations for Researchers	Researchers should extend this work by including supervisors, administrators, and policymakers, and by examining how GenAI shapes doctoral supervision, writing practices, research quality, and doctoral informing processes. Future studies should also investigate how doctoral students evaluate, verify, and integrate GenAI-generated information across different disciplines, institutions, and national contexts.
Impact on Society	The findings suggest that GenAI may reshape doctoral education and research more broadly by changing how students access academic support, develop research skills, and engage with knowledge production. They also highlight that without clear guidance, critical literacy, and equitable access, GenAI could reinforce existing inequalities and create new risks for academic integrity, making responsible governance essential for socially beneficial and inclusive higher education.
Future Research	Future research should compare doctoral GenAI use across disciplines, institutions, and countries, especially in underrepresented developing-country contexts. Longitudinal studies are also needed to examine how doctoral students' GenAI-

related competencies develop over time, including critical prompting, verification, disclosure, privacy awareness, contextual judgment, and responsible participation in a doctoral informing system.

Keywords

Generative AI, doctoral research, doctoral education, informing resource, academic writing, Botswana, qualitative study, research governance

INTRODUCTION

Generative AI (GenAI) has rapidly emerged as a significant development in higher education and research, with the capacity to generate human-like text, summarize information, support drafting, and assist with idea development across diverse academic tasks (Dwivedi et al., 2023; McGrath et al., 2024). These capabilities are particularly relevant to doctoral education, where researchers are expected to demonstrate sustained originality, critical judgment, methodological rigor, and increasing scholarly independence. GenAI may support these demands through drafting, editing, summarizing, planning, feedback generation and other research-related activities (English et al., 2026; Raitskaya & Tikhonova, 2024; Watermeyer et al., 2024; Wu et al., 2026; Xu & Shen, 2026). To examine these possibilities and their limitations, this study draws on the Informing Science perspective.

INFORMING SCIENCE PERSPECTIVE ON GENAI IN DOCTORAL RESEARCH

The Informing Science perspective views research and education as informing processes concerned with providing information to clients in a form, format, and schedule that maximize its effectiveness (Cohen, 2009). Informing Science is a transdiscipline concerned with the processes and conditions through which clients are informed; in educational contexts, the student may be understood as the client of the informing process (Cohen, 2009).

In doctoral research, GenAI tools, supervisors, institutional policies, and doctoral training structures can be understood as informing sources that provide guidance, feedback, explanations, and research support to doctoral students. The corresponding informing channels include GenAI platforms, supervisory interactions, workshops, institutional guidelines, and academic integrity procedures. The effectiveness of these processes depends on factors such as message quality, trust, accessibility, verification practices, privacy, contextual relevance, and institutional readiness.

Cohen's Informing Science framework highlights the roles of the informer, client, informing channel, task or need, context, environment, and the fragility of human information processing in shaping effective informing (Cohen, 2009). From this perspective, GenAI use in doctoral research is not merely a question of adopting a new technical tool. It also concerns how doctoral students receive, evaluate, verify, and act upon information within particular institutional and national environments. This study therefore conceptualizes GenAI as part of an emerging doctoral informing system in Botswana and examines its opportunities, challenges, and governance needs.

DOCTORAL RESEARCH AS A DISTINCT INFORMING CONTEXT

Doctoral education differs substantially from undergraduate and master's study. It requires candidates to make an original contribution to knowledge through independent research while also developing advanced methodological, analytical, and professional competencies (Council of Graduate Schools, 2005; European University Association [EUA], 2005, 2010; Gardner, 2009; Quality Assurance Agency for Higher Education [QAA], 2020; Yazdani & Shokooh, 2018). In Botswana's National Credit and Qualifications Framework (NCQF), doctoral graduates are expected to operate at the forefront of their fields, generate new knowledge of international standard, communicate their findings to varied audiences, and demonstrate intellectual independence and research leadership (Botswana Qualifications Authority, 2017). These expectations make doctoral study especially demanding and highlight the importance of the quality and reliability of the information available to doctoral candidates.

Doctoral work is also shaped by the central role of supervision. Rather than delivering structured instruction, supervisors guide candidates through complex intellectual, methodological, and professional challenges while supporting their transition into independent scholars (Austin, 2002; Lee & Danby, 2012; Walker et al., 2008). The dissertation is both a process and a product, requiring extensive engagement with literature, original data work, sustained analysis, and the production of a substantial scholarly contribution over several years (Gardner, 2009; Walker et al., 2008). This process is often accompanied by psychological pressures, including stress, uncertainty, isolation, perfectionism, and delayed progress (Gross et al., 2024; Martínez-García et al., 2025; Pyhältö et al., 2012; Stubb et al., 2011).

Within this demanding environment, GenAI may provide immediately available support for feedback, clarification, language assistance, task structuring, and preliminary exploration of research problems. However, its use also introduces substantial ethical, educational, and equity-related concerns. These include the risk of overreliance, erosion of core research skills, uncertainty around authorship and disclosure, and the potential widening of disparities in access to academic resources and digital capabilities (Giray, 2024; Hao et al., 2025; Lund et al., 2024). Uncritical use may reduce opportunities for doctoral candidates to develop independent analytical skills, thereby affecting the rigor, originality, and integrity of their research outputs (Harding & Boyd, 2024; Ma et al., 2026; Tensen et al., 2026). GenAI should therefore be understood as an informing resource whose value depends on critical engagement, verification, human judgment, and appropriate governance.

DOCTORAL RESEARCH IN BOTSWANA AND COMPARABLE DEVELOPING CONTEXTS

In Botswana and comparable developing-country settings, doctoral progress may be constrained by limited supervisory capacity, uneven digital infrastructure, limited access to scholarly resources, and institutional capacity gaps (Fan & Qiang, 2024; Nugraha & Hermawan, 2024; Zlotnikova & Hlomani, 2025; Zlotnikova et al., 2025). In many African universities, postgraduate supervision continues to rely heavily on a traditional one-to-one model. High student-to-supervisor ratios and insufficient institutional support may limit the frequency and depth of supervisory engagement (Agolla & Seeletso, 2025; Seeber & Horta, 2021). These conditions can contribute to delayed completion, weaker academic mentorship, and reduced research productivity. In such contexts, GenAI may operate as an additional informing channel by providing on-demand assistance with literature synthesis, technical writing, coding, methodological clarification, and formative feedback (Dai et al., 2023; Dang et al., 2024; Hoomanfar & Shamsi, 2025; Xu & Shen, 2026). Recent studies indicate that doctoral researchers use GenAI to support drafting, argument development, planning, and preparation for supervisory interactions (Lai et al., 2025; Wu et al., 2026; Zhang et al., 2026). Nevertheless, the availability of GenAI does not eliminate the need for human supervision. Instead, it may alter the relationship between students, supervisors, digital tools, and other sources of research guidance within the doctoral informing system.

POLICY AND GOVERNANCE GAPS IN GENAI USE FOR DOCTORAL RESEARCH

Although GenAI is already being used in doctoral research, its governance remains uneven and incomplete. Doctoral students may work in environments where the boundaries of acceptable use are unclear, particularly in relation to disclosure, authorship, confidentiality, and the distinction between legitimate assistance and academic misconduct (Bouaziz & Eddouada, 2026; English et al., 2026; Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025). GenAI may supplement supervision and other forms of academic support, but it may also reshape expectations concerning supervisory responsibilities, peer interaction, and researcher independence (English et al., 2026; Lai et al., 2025; Ma et al., 2026; Zhang et al., 2026). Clear institutional guidance is therefore needed to establish how GenAI may be used without displacing doctoral candidates' responsibility for intellectual judgment, analysis, and authorship.

A number of universities have introduced policies or guidelines addressing GenAI use in research and postgraduate education. However, emerging guidance remains fragmented and varies in the extent to which it addresses doctoral research practices. This inconsistency can create uncertainty for doctoral candidates who are expected to produce original work, use digital tools responsibly, and comply with evolving research-integrity standards. These challenges may be especially visible in African contexts, where students may face limited access to suitable digital devices, high broadband costs, and insufficient training in the safe and effective use of GenAI (Asamoah & Amarteifio, 2025; Baidoo-Anu et al., 2024). Institutional implementation may also be complicated by incomplete or uneven policies and limited context-sensitive guidance for doctoral students and staff (Asamoah & Amarteifio, 2025; Jacobs-Basadien & Pather, 2026; Zlotnikova & Hlomani, 2025).

These governance gaps are important because GenAI adoption in developing-country higher education is not only a question of technological access. It also involves information quality, equity, ethics, institutional readiness, and dependence on externally developed platforms. GenAI may reduce language barriers, support multilingual scholars, and broaden access to academic participation, including in resource-constrained settings (Pretorius et al., 2025). At the same time, inadequate infrastructure, uneven AI literacy, unclear policies, and unequal access to advanced tools may deepen existing inequalities or create new forms of exclusion and dependency (Asamoah & Amarteifio, 2025; Hao et al., 2025; Nyaaba et al., 2024).

In Botswana, where comprehensive doctoral-specific guidance on GenAI is still emerging, the central issue is therefore not only whether GenAI can support doctoral research. It is also how GenAI-generated information can be evaluated, verified, and used within a doctoral informing system that protects scholarly independence, academic integrity, equity, and human accountability.

The remainder of the paper reviews the relevant literature, describes the methodology, presents and discusses the findings, and concludes with the study's contributions, implications, limitations, and directions for future research.

LITERATURE REVIEW

Building on the conceptual and contextual framing established above, this section reviews existing evidence on GenAI use, doctoral supervision and scholarly development, academic integrity, and equity in developing-country contexts.

GENAI USES AND PERCEIVED BENEFITS IN DOCTORAL RESEARCH

A growing body of research shows that doctoral students use GenAI as a flexible academic support tool across multiple stages of research and writing. Common reported uses include literature scoping and synthesis, refining research questions, structuring arguments, explaining concepts, polishing academic language, generating feedback, and supporting task-specific activities such as coding or methodological description (Cowling et al., 2023; Dai et al., 2023; English et al., 2026; Hoomanfar & Shamsi, 2025; Kim et al., 2025; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Rafi & Amjad, 2025; Wu et al., 2026; Xu & Shen, 2026; Zhang et al., 2026). Across these studies, GenAI is often described as a readily available assistant that can provide immediate clarification, feedback, and drafting support, helping students prepare work before seeking supervisory input (Asamoah & Amarteifio, 2025; Cowling et al., 2023; Dai et al., 2023).

The reported benefits extend beyond efficiency alone. Several studies indicate that GenAI can reduce cognitive load associated with lower-level writing tasks and help students focus more on analysis, synthesis, and argument development (Kim et al., 2025; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Parker et al., 2025). For multilingual and non-native English-speaking doctoral researchers, language support is especially prominent, with GenAI helping reduce surface-level difficulties related to grammar, fluency, cohesion, and phrasing (Curado Fuentes, 2025; Dang et al., 2024; Hoomanfar & Shamsi, 2025; Ou et al., 2026; Pretorius et al., 2025; Tan, 2025; Zou et al., 2025).

Some studies also suggest that always-available, non-judgmental feedback can lower anxiety, sustain momentum, and create a low-stakes environment for experimentation and idea development (Cowling et al., 2023; Parker et al., 2025; Rafi & Amjad, 2025; Tensen et al., 2026).

EFFECT OF GENAI ON SUPERVISION AND SCHOLARLY DEVELOPMENT

A major theme in the literature is the effect of GenAI on doctoral supervision and scholarly development. When students use GenAI to address drafting, clarification, or language-level issues independently, supervision time may be redirected toward higher-value activities such as methodological rigor, conceptual framing, research ethics, and strategic feedback (Cowling et al., 2023; Dai et al., 2023; Lai et al., 2025; Rafi & Amjad, 2025; Xu & Shen, 2026). This suggests that GenAI does not necessarily reduce the importance of supervision; rather, it may change its focus. In this sense, the “division of cognitive labor” between the human supervisor and GenAI can become productive when expectations around disclosure, verification, and boundaries of use are explicit (Bouaziz & Eddouada, 2026; Dai et al., 2023; Harding & Boyd, 2024; Iatrellis et al., 2025; Kitcher, 1990).

At the same time, recent doctoral-focused studies show that GenAI can reshape help-seeking patterns and supervisory expectations. Lai et al. (2025) describe GenAI as an “alternative source of support” in doctoral training, while English et al. (2026) report that some researchers experience GenAI as “a great colleague.” These findings suggest that GenAI may supplement, and in some cases partially displace, traditional supervisory support, especially for low-stakes questions, idea development, and preparatory drafting. More broadly, the literature indicates that the developmental value of GenAI depends on how students engage with it. High-performing students tend to use it iteratively and critically — prompting, checking, revising, and integrating outputs with disciplinary standards — whereas copy-forward or non-iterative use is associated with weaker outcomes and greater risk of deskilling (Dang et al., 2024; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Zou et al., 2025). More recent work strengthens this argument by suggesting that GenAI may function differently depending on whether students use it primarily as a textual tool, a task assistant, or a thought partner, with each mode linked to different levels of critical engagement and research performance (Ma et al., 2026; Xu & Shen, 2026).

TEXTUAL TOOL: AUTHORSHIP AND INTEGRITY RISKS

The strongest concentration of evidence concerns the role of GenAI as a textual tool. Studies consistently show that GenAI can assist doctoral writers at macro-, meso-, and micro-levels: generating outlines, refining argument flow, improving coherence, suggesting transitions, correcting grammar, and supporting revision (Curado Fuentes, 2025; Dang et al., 2024; Hoomanfar & Shamsi, 2025; Kim et al., 2025; Nguyen, Ilesanmi, et al., 2024; Wu et al., 2026). These affordances are particularly valuable for students working in a second language, and for those seeking rapid formative feedback during drafting. However, the same studies warn that overreliance may weaken original voice, reduce critical judgment, and blur the boundary between support and substitution (Dang et al., 2024; Hoomanfar & Shamsi, 2025; Nguyen, Ilesanmi, et al., 2024; Zhang et al., 2026).

Concerns around integrity are central in this literature. These include plagiarism, or more specifically “AI-giarism” (Chan, 2024), ambiguity over provenance and authorship, hallucinated or unreliable content, bias in generated outputs, and insufficient transparency in acknowledging GenAI contributions (Bouaziz & Eddouada, 2026; Đerić et al., 2024; Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025; Nicholas et al., 2024; Watermeyer et al., 2024). Doctoral-specific studies further show that acceptable-use boundaries remain unclear in practice. English et al. (2026) found that doctoral researchers often used GenAI as a “time-saver, editor or colleague” while remaining uncertain about where appropriate use ends. Lai et al. (2025) identify tensions between “productivity-oriented research practices” and traditional academic norms, particularly around originality, integrity, and expectations of supervision. Bouaziz and Eddouada (2026) similarly show that where institutional guidance is weak or ambiguous, doctoral candidates may rely on informal peer advice and personal judgment, resulting in inconsistent disclosure and authorship practices. Related work also indicates that AI-mediated

writing can reshape writer identity, translanguaging practices, and perceptions of authorship among multilingual doctoral researchers (Ou et al., 2026; Zhang et al., 2026).

EQUITY, ACCESS, AND DEVELOPING-CONTEXT CONSIDERATIONS

Another major theme concerns equity and uneven access. Multi-country work with early-career researchers, including PhD candidates, suggests that access to advanced GenAI tools is becoming a new axis of academic inequality, with better-resourced users gaining cumulative advantages in language support, efficiency, and output quality (Nicholas et al., 2024). Institutional gaps — including unclear policies, inconsistent disclosure rules, lack of training, and uneven digital capacity — further shape who benefits from GenAI and under what conditions (Asamoah & Amarteifio, 2025; Nicholas et al., 2024; Watermeyer et al., 2024). Hao et al. (2025) similarly note that while GenAI may reduce some linguistic asymmetries in academia, these benefits remain unevenly distributed and depend heavily on access, literacy, and institutional support.

For developing and African contexts, the literature presents a dual picture. On the one hand, GenAI may help compensate for infrastructure and supervision constraints by offering support for writing, analysis, and language mediation (Asamoah & Amarteifio, 2025; Rafi & Amjad, 2025; Zlotnikova et al., 2025). Pretorius et al. (2025), drawing on a decolonial lens, argue that GenAI may also help multilingual scholars participate more fully in academic communication by reducing language gatekeeping. On the other hand, limited infrastructure, patchy digital access, weak policy frameworks, and dependence on externally developed systems may deepen rather than reduce inequalities (Asamoah & Amarteifio, 2025; Nyaaba et al., 2024). These concerns are particularly important for doctoral education in African contexts, where support structures are often stretched and where context-sensitive governance remains underdeveloped.

SYNTHESIS AND RESEARCH GAP

A summary of studies on GenAI use by doctoral students is provided in Supplementary Table S1, available in the accompanying dataset in the Figshare repository (Zlotnikova, Mokgetse, & Hlomani, 2026). These studies show that GenAI is being used across a wide range of doctoral tasks, most consistently in academic writing, language refinement, brainstorming, literature review and synthesis, draft revision, and formative feedback. A smaller but growing body of work also reports its use in coding, data analysis, methodological exploration, supervisory preparation, and broader research workflow support. Overall, the literature indicates that GenAI can improve writing, feedback, productivity, idea development, and confidence, particularly among multilingual and second-language doctoral researchers.

The strongest evidence points to benefits when GenAI is used iteratively, critically, and transparently, with clear expectations around disclosure, verification, and supervisory oversight (Dang et al., 2024; Harding & Boyd, 2024; Iatrellis et al., 2025; Parker et al., 2025). Conversely, uncritical or substitutive use is associated with overdependence, weakened originality and critical judgment, unreliable or biased content, authorship and disclosure ambiguity, privacy risks, and unequal access to advanced tools and training (Hoomanfar & Shamsi, 2025; Nicholas et al., 2024; Rafi & Amjad, 2025; Watermeyer et al., 2024). These concerns have increased attention to trainable doctoral competencies such as critical prompting, verification, disclosure, privacy awareness, and context-sensitive judgment (Parker et al., 2025; Rebouças de Lira et al., 2026). Several studies also suggest that these risks are developmental as well as ethical, because uncritical use of GenAI may weaken independent scholarly judgment, blur the boundaries of legitimate support, and alter supervision dynamics in ways that are not yet fully understood.

Two further patterns emerge from the literature. First, existing research remains concentrated on writing-related support, while GenAI use in methodology design, data collection and analysis, ethics applications, viva preparation, project management, and doctoral supervision is less developed. Second, doctoral students engage with GenAI in different ways: some use it mainly as an editing tool,

whereas others treat it as a broader research assistant or source of intellectual dialogue. These differences reinforce the view that developmental outcomes depend not simply on access to GenAI, but on whether it is used critically, iteratively, and with appropriate supervisory and institutional support.

Despite this growing body of work, doctoral-specific evidence remains limited. Many studies still combine undergraduate, postgraduate, and early-career researcher populations, with relatively few isolating doctoral cohorts or examining doctoral supervision in depth (English et al., 2026; Lai et al., 2025). In addition, much of the literature remains Global North-centered, while resource-constrained contexts such as Botswana remain understudied despite clear potential for both benefit and harm (Asamoah & Amarteifio, 2025; Rafi & Amjad, 2025; Zlotnikova et al., 2025). Supervisors' perspectives, discipline-specific expectations, and measurable research outcomes are also insufficiently addressed. Self-regulated and metacognitive GenAI use is also only beginning to be articulated as a set of trainable and assessable doctoral competencies (Dang et al., 2024; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Rebouças de Lira et al., 2026; Xu & Shen, 2026). Taken together, the literature suggests that the benefits of GenAI are conditional on critical use, clear guidance, appropriate supervision, and context-sensitive institutional support. These gaps demonstrate the need for context-sensitive empirical research on GenAI in doctoral research practices in Botswana.

METHODOLOGY

STUDY PURPOSE AND RESEARCH QUESTIONS

This study examines how GenAI functions as an informing resource in doctoral research in Botswana, the challenges affecting its effective use, and the governance conditions required for its responsible integration. Guided by the Informing Science perspective, the study focuses on how doctoral students receive, evaluate, verify, and act upon information provided through GenAI tools and related institutional channels. It seeks to generate context-sensitive evidence that can inform academically responsible, practically useful, and equitable institutional responses to GenAI use in doctoral research.

The study addresses the following research questions:

Research Question 1: How can GenAI function as an informing resource that supports key aspects of doctoral research practices in Botswana?

Research Question 2: What challenges affect the effective use of GenAI as an informing resource in doctoral research practices in Botswana?

Research Question 3: What policies and guidelines can ensure the ethical and effective integration of GenAI in doctoral research in Botswana as part of a responsible doctoral informing system?

RESEARCH DESIGN

An exploratory qualitative design was adopted to address the research questions through an in-depth examination of doctoral students' experiences and perceptions of GenAI use. Consistent with the Informing Science perspective introduced earlier, the study treated GenAI use as an informing process in which doctoral students receive, evaluate, verify, and act upon information provided through GenAI tools and related institutional channels. A qualitative approach was appropriate because the study sought to develop an in-depth understanding of participants' experiences and perceptions in a relatively underexplored context. Data were generated through semi-structured interviews with doctoral students and analyzed using qualitative thematic analysis.

Institutional ethics approval was obtained for the study (ethical clearance HREC-029). Informed consent was secured from all participants, participation was voluntary, and participants were free to

withdraw at any stage. All interview data were treated confidentially, and participants are identified in the findings using codes rather than names.

SETTING AND CONTEXT

The study was conducted at a public university of science and technology in Botswana, a landlocked country in Southern Africa. The context is marked by uneven digital infrastructure and constrained supervision capacity, making it relevant for examining equitable, ethical, and effective GenAI adoption in doctoral work (Asamoah & Amarteifio, 2025; Pretorius et al., 2025; Zlotnikova & Hlomani, 2025; Zlotnikova et al., 2025).

PARTICIPANTS AND SAMPLING

The study involved 15 doctoral students from science and engineering disciplines at a single public university in Botswana. The focus on science and engineering reflected the disciplinary profile of the institution and enabled the study to examine GenAI use within research-intensive doctoral programs. These disciplines were also considered particularly relevant because their research practices frequently involve computationally demanding, data-intensive, and iterative activities, including statistical analysis, technical writing, programming, and coding, for which GenAI tools are increasingly used. They therefore provided an information-rich context for examining both the opportunities and governance risks associated with GenAI use.

The selection of a single institution was consistent with the exploratory qualitative aim of developing an in-depth, context-sensitive understanding rather than producing statistically generalizable findings (Creswell & Poth, 2023). Consistent with purposeful sampling, the institution was selected as an information-rich setting capable of illuminating the study questions (Patton, 2015). Its constrained supervisory capacity and uneven digital infrastructure made it particularly relevant for examining the ethical and equitable adoption of GenAI in doctoral research (Asamoah & Amarteifio, 2025; Zlotnikova & Hlomani, 2025; Zlotnikova et al., 2025).

Participants were recruited through purposive sampling based on their ability to provide relevant accounts of GenAI use in doctoral research, with recruitment also shaped by feasible access within the study setting. Eligible participants were currently enrolled doctoral candidates who self-reported experience using GenAI for research-related tasks such as writing, analysis, literature review, or coding. Individuals without experience of using GenAI for research-related activities, or those unwilling to consent and participate, were excluded. Recruitment was conducted through institutional and program-level communication channels available to the researchers. A total of 28 potentially eligible science and engineering doctoral students were contacted. Eighteen responded, while 10 either did not respond or declined to participate. Of the 18 respondents, three were unable to participate within the data-collection period, resulting in a final sample of 15 students who volunteered and provided informed consent.

Given the focused study aim and the relative homogeneity of the participants' institutional and disciplinary context, sample adequacy was guided by the principle of information power rather than by a predetermined numerical saturation target (Malterud et al., 2016). The 15 participants were considered sufficient to generate rich cross-case comparisons and recurring thematic patterns. In addition, no substantively new themes emerged during the final three interviews, suggesting that thematic saturation had been reasonably approached within the exploratory scope of the study (Guest et al., 2006).

Participant characteristics, including doctoral stage, broad disciplinary area, gender, and self-reported level of GenAI experience, are summarized in Table 1. To reduce the risk of identification within this small, single-institution sample, these characteristics are reported in aggregate. For reporting purposes, the original anonymized participant identifiers were recoded as P01–P15.

Table 1. Summary of participant characteristics

CHARACTERISTIC	CATEGORY	N	FREQUENCY (%)
Doctoral stage	Year 1	3	20.0
	Years 2-5	10	66.7
	Not specified	2	13.3
Broad discipline	Engineering	9	60.0
	Science	6	40.0
Gender	Female	6	40.0
	Male	9	60.0
Self-reported GenAI experience	Experienced	11	73.3
	Moderate	2	13.3
	Minimal	2	13.3

DATA SOURCES AND COLLECTION PROCEDURES

Data were collected primarily through in-depth, semi-structured interviews. The interviews were conducted in English using an interview guide designed around the three research questions. The questions explored participants' use of GenAI in doctoral research, the benefits they experienced, the challenges they encountered, and their views on appropriate institutional policies and ethical guidelines. The semi-structured format allowed the researcher to maintain consistency across interviews while also probing emerging issues in greater depth.

Interviews were conducted either face-to-face or online, depending on participant availability and practical access. Each interview lasted approximately 30–60 minutes depending on the depth of participants' responses, their familiarity with GenAI concepts, and the need for clarification or follow-up questions.

Interview themes and sample questions are provided in Table 2.

Table 2. Interview themes and sample questions

THEME	FOCUS	SAMPLE QUESTIONS
Lived experience of GenAI in doctoral work	First contact; typical tasks; benefits and pain points	"Walk me through how you used GenAI in your last literature or methods task"
Ethics, disclosure, and responsibility	How participants decide what is acceptable; concerns about responsible use	"What concerns do you have about using GenAI in doctoral research?"
Verification and quality	Fact-checking, triangulation, reproducibility	"How do you verify outputs and decide what to keep or discard?"
Challenges and constraints	Technical, financial, academic, and contextual challenges	"What challenges have you faced when using GenAI tools in your doctoral studies?"

THEME	FOCUS	SAMPLE QUESTIONS
Policy and guideline recommendations	Suggested rules, training, disclosure, and institutional support	“What policies or guidelines do you think universities should introduce for the ethical use of GenAI in doctoral research?”

Interviews were audio-recorded and transcribed verbatim. Each participant was assigned a code number for anonymization, and identifying information was removed from the transcripts prior to analysis.

METHODS OF DATA ANALYSIS

The interview transcripts were analyzed using qualitative thematic analysis. The analysis was iterative and focused on identifying recurring patterns relevant to the three research questions. Coding combined inductive thematic analysis with subsequent conceptual alignment to the Informing Science framework. Initial codes were generated from participants’ responses, then grouped into themes corresponding to GenAI as an informing resource, challenges in effective informing, and governance conditions for responsible doctoral informing.

The coding process was conducted manually using a shared spreadsheet-based coding matrix by the first and second authors. First, the transcripts were read repeatedly to achieve familiarity with the data. Second, meaningful segments of text were coded according to participants’ descriptions of GenAI use, challenges, ethical concerns, and recommendations. Each code was linked to the relevant participant extract and assigned a brief descriptive label. As coding progressed, the two researchers compared and reviewed the developing codes. Overlapping codes were merged, broad codes were divided where necessary, and code labels and definitions were refined to improve consistency. Differences in coding or interpretation were discussed and resolved through consensus. The third author reviewed the developing coding framework, selected coded extracts, and the candidate themes, and contributed to discussions where further clarification or refinement was required. Third, related codes were grouped into broader categories and candidate themes. Fourth, the themes were reviewed against the coded extracts and the full dataset, revised where necessary, and subsequently aligned with the three research questions and the Informing Science perspective to ensure that the final analytical structure reflected both participants’ accounts and the study’s conceptual framing. All three authors reviewed and agreed on the final thematic structure. The Informing Science framework was therefore used to interpret and organize the developed themes rather than as a predetermined coding structure.

Frequency counts were calculated after theme development. Each participant was counted once per theme where the theme was explicitly mentioned, even if the participant referred to the same issue multiple times. Participants could be coded under more than one theme. These counts are reported as indicative frequencies to show the relative prominence of themes in the dataset; they are not intended as statistical measures or generalizable prevalence estimates.

Trustworthiness was supported through careful transcription, repeated engagement with the data, systematic manual coding, researcher comparison and consensus, independent analytical review by the third author, and the use of direct participant quotations in the findings. An audit trail of coding decisions, theme development, code refinement, consensus discussions, third-author review, and frequency-counting decisions was maintained to strengthen transparency and dependability.

RESULTS

This section presents the findings from the qualitative analysis of interviews with 15 doctoral students from science and engineering disciplines. The results are organized around the three research questions and focus on GenAI as an informing resource in doctoral research, the challenges affecting

effective GenAI-based informing, and participants' recommendations for responsible integration in a doctoral informing system in Botswana. The findings are presented thematically and supported by the analytical patterns identified across participants' accounts. Frequencies are used descriptively to indicate how many participants mentioned each theme at least once. They are not intended as statistical generalizations.

GENAI AS AN INFORMING RESOURCE SUPPORTING DOCTORAL RESEARCH PRACTICES (RESEARCH QUESTION 1)

Reported uses of GenAI as an informing resource

Participants described GenAI as an informing resource across several stages of doctoral research. The frequency and depth of use varied across different doctoral research tasks.

The most prominent theme was the use of GenAI for idea development. Participants reported using GenAI to brainstorm possible directions, narrow broad topics, clarify unfamiliar concepts, and organize early thinking around doctoral research tasks. Rather than presenting GenAI as replacing their own intellectual work, participants generally described it as a preliminary informing resource that helped them explore options and refine initial ideas before making their own decisions. For example, Participant 05 indicated that they began using GenAI at the early stages of doctoral work, particularly to clarify unfamiliar concepts. Some participants also emphasized that they retained intellectual ownership over topic formulation and introductory framing, suggesting that GenAI was used mainly to stimulate, clarify, and structure thinking rather than to determine the direction of the research. Participant 14 provided a more detailed example, explaining that GenAI helped broaden a topic that had initially appeared too narrow: *"I was a bit narrow, so it helped me to expand and add ideas to my topic and to make it a better topic."* The accounts were not uniform, however. Participant 02 found that GenAI frequently produced *"general results"* and did not *"specifically narrow to what I really need."* These contrasting experiences indicate that the perceived usefulness of GenAI for idea development depended on the specificity of the task, the relevance of the generated response, and the participant's ability to direct the interaction.

The second most prominent theme was literature review support. Participants reported using GenAI to summarize literature, clarify key concepts, identify relationships among ideas, and move more quickly from searching to synthesis. As Participant 09 explained, GenAI helped them *"summarize information in such a way that you can be able to read out the main points and understand the subject matter better."* Participant 10 similarly noted that GenAI accelerated the process of searching, reviewing, and synthesizing relevant material. In Informing Science terms, GenAI functioned as an accessible preliminary informing channel that helped students organize and interpret literature before engaging more deeply with academic sources.

Participants also highlighted proofreading and language support as important forms of informing support. They described using GenAI to improve sentence structure, grammar, clarity, and academic tone. Participant 11 noted that the cost of external editing services could be difficult to manage alongside other research expenses, and stated that GenAI tools had *"relieved that pressure from our studies."* This indicates that GenAI was valued not only for textual correction, but also for reducing some access barriers to language-related academic support.

Another recurring theme was methodological support. Participants reported using GenAI to clarify methodological concepts, understand research design options, and obtain guidance on structuring the methodology section. Some also noted that GenAI provided accessible step-by-step explanations that reduced reliance on paid short courses or subscription-based support for learning methodological concepts. Participants nevertheless treated this support cautiously, using the outputs as provisional guidance that required verification, interpretation, and human judgment rather than as a substitute for their own academic work.

Data analysis and programming support appeared as a more limited theme, reported by four participants. Participants described GenAI as a supplementary informing resource for understanding software, statistical procedures, coding, and debugging rather than as a primary analytical tool. For example, Participant 07 reported using GenAI “to help me [with] understanding the R programming errors” and to clarify “statistical methods like PCA.” Participant 13 similarly explained that, because they were unfamiliar with R, GenAI could “help you to install [and] set up [R] ... and help you like a tutor.” Overall, these accounts suggest that GenAI was used mainly to support learning and troubleshooting, while analytical decisions remained the researcher’s responsibility. All four participants who reported data-analysis or programming support were from engineering disciplines. This may reflect the prominence of software, coding, and computational tasks in their reported doctoral work; however, given the small sample, it should be interpreted as an indicative pattern rather than a general disciplinary difference.

A summary of GenAI’s reported informing functions across doctoral research tasks is presented in Table 3.

Table 3. Summary of GenAI’s reported informing functions across doctoral research tasks

THEME	WHAT PARTICIPANTS REPORTED	FREQUENCY	PARTICIPANTS WHO MENTIONED THE THEME
Idea development	Brainstorming, narrowing topics, structuring sections	n = 12/15 (80.0%)	P01, P02, P03, P05, P06, P08, P09, P11, P12, P13, P14, P15
Literature review support	Searching, summarizing, identifying themes and gaps	n = 11/15 (73.3%)	P01, P02, P03, P05, P06, P07, P08, P09, P10, P11, P12
Proofreading and language refinement	Grammar, sentence structure, academic tone	n = 8/15 (53.3%)	P01, P04, P05, P06, P07, P09, P12, P15
Methodological clarification	Explaining research methods and software guidance	n = 6/15 (40.0%)	P05, P06, P07, P10, P11, P13
Data analysis and programming support	R, coding, debugging, statistical explanations	n = 4/15 (26.7%)	P06, P07, P08, P13

Note. Frequencies are indicative and refer to the number of participants who mentioned each theme at least once. Participants could be coded under more than one theme.

Reported GenAI tools and their uses in doctoral research

Participants reported using a range of GenAI tools in their doctoral research, although the breadth and depth of use varied across individuals. Some relied on a small number of tools for specific tasks, while others reported broader and more varied use across multiple stages of doctoral work. Participant 12 described extensive use of multiple platforms for different research purposes, stating: “I have experimented with the multiple GenAI tools and found where they can be useful in my research. I use Grammarly for spelling and grammar check, SciSpace for literature synthesis, and ChatGPT for methodological clarification.” In contrast, Participant 04 reported a deliberately narrow pattern of use: “Mostly use Grammarly. I know ChatGPT and DeepSeek but I avoid using them.” This contrast shows that participants varied considerably in how broadly they incorporated available tools into their research practices.

Across participants, ChatGPT emerged as the most frequently mentioned tool and was used across the broadest range of research activities. Grammarly, Grok, Google Gemini, and Microsoft Copilot

were each mentioned by four participants and were used for more specialized forms of academic support. Other tools, including DeepSeek, SciSpace, Perplexity, QuillBot, and Claude, were generally used for narrower functions such as literature synthesis, focused searching, language refinement, verification, programming, and debugging.

Some participants described using GenAI selectively for idea generation, proofreading, or methodological clarification, while others incorporated multiple tools into a broader workflow. Differences were also evident between novice and more experienced users. Participant 03 stated, “*I’m a newbie. I’m just learning how to use it,*” and remained skeptical about the reliability of the outputs. Participant 15 described a developmental shift from initially relying on GenAI to create paragraphs toward using it more selectively, explaining that its role had become primarily to “*fix the English*” rather than generate the underlying content. These contrasting accounts suggest that participants’ patterns of use could become more selective and critical as their disciplinary knowledge and experience with GenAI developed.

The reported GenAI tools and their main uses as informing channels are presented in Table 4.

Table 4. Summary of the reported GenAI tools and their main uses as informing channels

TOOL	MAIN REPORTED USES	FREQUENCY	PARTICIPANTS WHO MENTIONED THE TOOL
ChatGPT	Idea and concept development, literature-related support, methodological guidance, writing support, and data analysis support	n = 14/15 (93.3%)	P01, P02, P03, P05, P06, P07, P08, P09, P10, P11, P12, P13, P14, P15
Grammarly	Spelling, grammar, language refinement	n = 4/15 (26.7%)	P01, P04, P11, P12
Grok	General academic support, summaries	n = 4/15 (26.7%)	P08, P09, P12, P15
Google Gemini	General academic querying, software/methods guidance	n = 4/15 (26.7%)	P09, P12, P13, P15
Microsoft Copilot	General academic support	n = 4/15 (26.7%)	P10, P11, P12, P14
DeepSeek	Research support, verification, coding/programming support	n = 3/15 (20.0%)	P05, P06, P12
SciSpace	Literature synthesis	n = 3/15 (20.0%)	P01, P10, P12
Perplexity	Focused searching and querying	n = 2/15 (13.3%)	P03, P15
QuillBot	Paraphrasing and language refinement	n = 2/15 (13.3%)	P05, P12

Note. Frequencies refer to the number of participants who reported using each GenAI tool for research-related purposes. Participants could report more than one tool. Tools that participants had

only heard of or explicitly stated that they avoided using were not counted. Tools reported by only one participant each were Claude (P06), Bohrium (P01), Nano Banana (P05), Meta AI (P08), Jenni AI (P09), PMI Infinity (P10), Sequence (P11), and ResearchRabbit (P12).

CHALLENGES IN GENAI-BASED INFORMING FOR DOCTORAL RESEARCH PRACTICES (RESEARCH QUESTION 2)

Participants identified several challenges affecting the effective use of GenAI as an informing resource in doctoral research. These challenges concerned the quality and traceability of information, the risk of dependence, institutional governance, affordability and access, contextual relevance, and data protection. Collectively, they show that access to GenAI alone did not guarantee effective informing.

A prominent challenge concerned the accuracy and reliability of GenAI-generated content. Participants expressed concern that GenAI tools could produce inaccurate, fabricated, or contextually inappropriate outputs, including unreliable references and unsupported information. Closely related, but analytically distinct, was the difficulty of verifying and tracing the origin of apparently plausible content. Reliability concerned the quality of the outputs themselves, whereas verification and traceability concerned participants' ability to establish their origin, credibility, and accuracy before incorporating them into doctoral research. Participants emphasized the need to check, verify, and validate outputs before using them in academic work. Participant 06 provided a concrete example, reporting that GenAI sometimes generated "*non-existing citations*," requiring the participant to verify whether the cited journal and article actually existed. Participant 03, by contrast, reported that they had not yet encountered accuracy problems. This outlier account should be interpreted in light of the participant's minimal experience and limited use of the tools at the time of the interview.

Another important theme was the risk of overreliance. Some participants worried that excessive dependence on GenAI could weaken critical thinking, independent judgment, and the development of core research skills. As Participant 14 stated, "*Are we going to produce scientists or writers from our country or from the world at large who cannot write?*" Participant 15 similarly reflected that early reliance on GenAI-generated paragraphs had made them feel "*a little bit dumb*." The participant subsequently changed their approach, using GenAI primarily to refine language after independently developing and researching the content. This account illustrates that participants could recognize potentially substitutive patterns of use and intentionally adopt a more selective approach.

Policy uncertainty was also a major concern. Participants pointed to the absence of clear institutional policies as a source of uncertainty, particularly where supervisors and students may hold different views about acceptable use. Participant 01, for example, stated that "*There is bias because of the lack of policies for both students and supervisors on the use of AI*." For Participant 04, such uncertainty directly affected actual tool use: the participant relied mainly on Grammarly and avoided broader GenAI platforms because of uncertainty about whether AI-supported work might be detected or regarded as inappropriate. This indicates that policy ambiguity could discourage potentially legitimate uses as well as fail to prevent misuse.

Participants also identified financial and access-related challenges. Some noted that the full functionality of GenAI tools often depended on paid subscriptions, premium packages, or more stable digital access than was always available to them. Participant 04 emphasized that access to more capable features frequently required payment and that "*not everybody ... can afford to pay*," particularly when subscription charges were denominated in foreign currency. This account contrasts with Participant 05's view that online availability meant there were no obstacles unique to Botswana, illustrating that participants experienced affordability and access differently.

A further challenge related to contextual mismatch and bias. Some participants felt that GenAI tools did not always respond adequately to African or Botswana-specific research contexts. Participant 10

linked this issue to the predominance of externally developed AI systems, stating, “*AI was invented in the United States of America. You see the bias when you are a researcher ... trying to contextualize to Africa.*”

Privacy and security concerns were less frequently mentioned but remained important. Participants expressed unease about entering sensitive, unpublished, or personally identifiable information into GenAI platforms, particularly when the handling of such data was unclear. As Participant 05 noted, “*There is also an issue of privacy and security. We fill these tools with some [information] ... that is private like personally identifiable data and we do not know what it is doing and where it is going.*”

The summary of participants’ reported challenges in effective GenAI-based informing in doctoral research is presented in Table 5.

Table 5. Summary of reported challenges in effective GenAI-based informing in doctoral research

THEME	WHAT PARTICIPANTS REPORTED	FREQUENCY	PARTICIPANTS WHO MENTIONED THE THEME
Reliability and accuracy of outputs	Hallucinations, inaccurate information, fabricated or unreliable references, contextually inappropriate responses	n = 13/15 (86.7%)	P01, P02, P04, P05, P06, P07, P08, P09, P11, P12, P13, P14, P15
Overreliance and skill erosion	Concerns about reduced critical thinking, independent judgment, and core research skills	n = 11/15 (73.3%)	P01, P02, P04, P05, P06, P07, P08, P09, P12, P13, P14
Verification and traceability	Difficulty checking the origin and credibility of generated content	n = 10/15 (66.7%)	P02, P04, P05, P06, P07, P08, P11, P12, P13, P15
Policy uncertainty	Lack of clear institutional guidance and differing expectations between students and supervisors	n = 9/15 (60.0%)	P01, P03, P05, P06, P08, P11, P12, P13, P14
Financial and access barriers	Subscription costs, premium packages, unequal access, and connectivity limitations	n = 5/15 (33.3%)	P01, P02, P04, P09, P13
Contextual mismatch and bias	Difficulty applying GenAI effectively to African or Botswana-specific contexts	n = 3/15 (20.0%)	P01, P10, P14
Privacy and security concerns	Risks of entering sensitive, unpublished, or personally identifiable data into GenAI platforms	n = 3/15 (20.0%)	P03, P05, P12

Note. Frequencies are indicative and refer to the number of participants who mentioned each theme at least once. Participants could be coded under more than one theme.

POLICIES AND GUIDELINES FOR ETHICAL AND EFFECTIVE INTEGRATION IN A RESPONSIBLE DOCTORAL INFORMING SYSTEM (RESEARCH QUESTION 3)

Participants proposed a number of policy and guideline measures to support the ethical and effective integration of GenAI in doctoral research. Their recommendations combined individual responsibility, formal institutional governance, transparency, educational integration, and capacity development. Viewed through the Informing Science perspective, these recommendations point to the conditions needed for a responsible doctoral informing system, including trustworthy channels, clear rules, human accountability, and shared expectations between students, supervisors, and institutions.

The most frequently reported recommendation concerned responsibility and integrity. Participants associated ethical GenAI use with checking outputs, acknowledging assistance, and maintaining human responsibility for the final research product. They also linked misuse to plagiarism and emphasized that doctoral students should remain accountable for interpreting, verifying, and approving the final research product.

Some participants also recommended clearer boundaries around acceptable use. This included suggestions such as setting limits on the extent of GenAI assistance and using AI detection tools to identify undisclosed AI-generated content. However, participants' recommendations also suggested that boundaries should not be limited to detection or prohibition; they should clarify how GenAI can be used constructively without replacing doctoral students' own judgment, analysis, and authorship.

Participants further suggested that GenAI-related guidance should be embedded within existing academic misconduct and governance frameworks rather than treated as an isolated issue. Participant 01, for example, argued that integrating AI regulations into existing misconduct policies would better align GenAI governance with institutional academic standards.

Another major theme concerned the need for clearer policy enforcement and formal guidance. Participants indicated that policies would be ineffective if they were introduced without monitoring mechanisms, reporting procedures, and clear consequences for misuse. Related to this was the recommendation that the use of GenAI should be accompanied by formal declaration statements indicating where and how such tools were used in research. These recommendations suggest that transparency and accountability are central to responsible GenAI-based informing.

Participants differed in the balance they placed on enforcement and educational support. While some supported AI-detection tools, explicit limits, and sanctions for misuse, others emphasized that GenAI should not be approached only through restriction and recommended its structured integration into teaching and learning. This view is reflected in Participant 02's comment: "*Stop wasting money buying plagiarism software, rather buy software that students can integrate into their learning.*" Although expressed informally, this comment captures a wider participant concern that institutions should invest not only in detecting misuse, but also in enabling responsible, educationally meaningful use. The contrast suggests that participants did not necessarily regard enforcement and educational integration as mutually exclusive; rather, responsible governance would require clear boundaries alongside legitimate opportunities, access, and support for appropriate use.

Finally, participants recommended workshops and seminars on GenAI use in doctoral research. Participant 13 explained that "*we actually don't have knowledge on how to use AI*" and concluded that "*we need more guidance, we need more teaching on how to use it.*" Such training was viewed as necessary for strengthening students' ability to evaluate, verify, and responsibly use GenAI-generated information. Training was therefore understood as both skills development and a governance mechanism for establishing shared expectations among students and supervisors.

The summary of participants' recommendations for responsible GenAI integration in a doctoral informing system is shown in Table 6.

Table 6. Summary of participants' recommendations for responsible GenAI integration in a doctoral informing system

THEME	WHAT PARTICIPANTS RECOMMENDED	FREQUENCY	PARTICIPANTS WHO MENTIONED THE THEME
Responsibility and integrity	Emphasizing checking, acknowledgment, human accountability, and the relationship between GenAI use and plagiarism	n = 15/15 (100.0%)	P01, P02, P03, P04, P05, P06, P07, P08, P09, P10, P11, P12, P13, P14, P15
Boundaries of acceptable use	Clear limits on supportive versus excessive use, including possible use of AI detection tools	n = 14/15 (93.3%)	P01, P02, P03, P05, P06, P07, P08, P09, P10, P11, P12, P13, P14, P15
Integration into existing governance	Embedding GenAI regulation within existing academic misconduct and institutional governance frameworks	n = 11/15 (73.3%)	P01, P02, P05, P06, P07, P09, P10, P11, P12, P13, P14
Declaration and transparency	Formal disclosure of where and how GenAI tools were used in research	n = 8/15 (53.3%)	P02, P04, P06, P07, P09, P12, P13, P14
Policy enforcement and monitoring	Clear enforcement strategies, reporting mechanisms, and consequences for misuse	n = 8/15 (53.3%)	P01, P05, P07, P09, P10, P11, P12, P14
Structured educational integration	Incorporating GenAI into learning processes to support responsible and critical use	n = 6/15 (40.0%)	P02, P10, P11, P13, P14, P15
Workshops and seminars	Training and awareness creation for students and supervisors on GenAI capabilities, limitations, and ethics	n = 6/15 (40.0%)	P01, P03, P06, P11, P13, P14

Note. Frequencies are indicative and refer to the number of participants who mentioned each theme at least once. Participants could be coded under more than one theme.

DISCUSSION

DISCUSSION OF FINDINGS ON GENAI AS AN INFORMING RESOURCE FOR DOCTORAL RESEARCH PRACTICES (RESEARCH QUESTION 1)

The findings for Research Question 1 show that doctoral students in Botswana used GenAI as an informing resource across several stages of doctoral research. The strongest reported use was idea development, followed by literature review support, indicating that GenAI was most often used to stimulate, clarify, and organize early thinking rather than to replace doctoral students' own research judgment. Although this pattern is broadly consistent with studies describing GenAI as a flexible resource across research and writing activities (Cowling et al., 2023; Dai et al., 2023; Hoomanfar & Shamsi, 2025; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Wu et al., 2026; Xu & Shen,

2026), participants did not experience its value uniformly. Some described GenAI as an extensive and flexible research aid, while others found its responses too general, restricted their use to narrow tasks, or deliberately avoided certain platforms because of uncertainty about acceptable use. Access alone therefore did not necessarily produce meaningful integration. Rather, its value appears conditional on disciplinary knowledge, GenAI experience, task specificity, and users' ability to evaluate and direct the informing process.

The dominance of idea development and literature review support indicates that GenAI use remained concentrated on formative, explanatory, and writing-related tasks rather than the full research workflow. This pattern supports previous research on literature synthesis and drafting assistance. Although previous studies report wider use for coding, data analysis, methodological exploration, and workflow integration (Hoomanfar & Shamsi, 2025; Iatrellis et al., 2025; Lai et al., 2025; Rafi & Amjad, 2025; Xu & Shen, 2026), these uses remained secondary in the Botswana sample. This concentration may reflect sensible caution, but it may also indicate limited access to specialized tools, uneven confidence, insufficient training, or uncertainty about the legitimacy of using GenAI for higher-risk research tasks. From an Informing Science perspective, GenAI was most readily used where the information could be treated as preliminary and easily checked, and less readily used where errors could directly affect methodological validity or research conclusions.

The findings on proofreading and language support align with previous studies, especially those focusing on multilingual and second-language doctoral researchers (Dang et al., 2024; Hoomanfar & Shamsi, 2025; Pretorius et al., 2025; Tan, 2025). In Botswana, participants also valued this support because it reduced dependence on costly editorial services. However, GenAI may transfer dependence from costly human editing services to externally controlled commercial platforms whose advanced features may themselves require payment. It therefore mitigates some financial pressure without eliminating the need for accessible institutional writing support. GenAI-assisted language development should complement rather than replace institutional academic writing support and supervision.

Participants used GenAI to clarify methodological concepts, understand research design options, and structure the methodology section, consistent with previous research on methods exploration and guidance (Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025; Iatrellis et al., 2025; Rafi & Amjad, 2025). Their emphasis on verification and limited reliance nevertheless shows a more cautious pattern than some optimistic accounts in the literature. Caution was not necessarily uniform or sufficient. Students with limited methodological experience may have greater difficulty identifying plausible but inappropriate guidance. The developmental value of GenAI may therefore depend on continued supervisory guidance and review rather than on individual verification alone.

The study also shows that doctoral students did not use GenAI uniformly. ChatGPT was the most frequently mentioned tool, while Grammarly, SciSpace, QuillBot, Perplexity, DeepSeek, and Claude served narrower functions. One possible interpretation is that the predominance of ChatGPT reflects familiarity and accessibility rather than its suitability for every research task. Such platform concentration may encourage reliance on a general-purpose tool when specialized tools or conventional scholarly sources would be more appropriate. Differences among novice, selective, and multi-platform users further indicate varying levels of critical engagement, supporting the distinction between GenAI as a textual tool, task assistant, or thought partner (Ma et al., 2026; Xu & Shen, 2026). The concentration of data analysis and programming support among engineering participants may indicate disciplinary variation, but the small sample does not permit firm comparison. This pattern supports discipline-sensitive rather than uniform institutional guidance.

DISCUSSION OF FINDINGS ON CHALLENGES IN EFFECTIVE GENAI-BASED INFORMING IN DOCTORAL RESEARCH PRACTICES (RESEARCH QUESTION 2)

Participants identified concerns about reliability, overreliance, verification, policy uncertainty, access, contextual mismatch, and privacy. These concerns reflect recurrent challenges reported in previous research (Bouaziz & Eddouada, 2026; Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025; Nicholas et al., 2024; Rafi & Amjad, 2025; Watermeyer et al., 2024) and show that such risks are also experienced in doctoral research practice in Botswana. Participants varied in the risks they reported: some novice or less intensive users had not encountered accuracy problems, while others described fabricated references and serious reliability concerns. This variation may reflect differences in exposure, task type, disciplinary knowledge, or the ability to recognize errors. From an Informing Science perspective, effective informing therefore depends on the quality, credibility, traceability, accessibility, and governance of GenAI outputs, not merely on tool availability.

Reliability and accuracy were the strongest concerns. Participants described inaccurate outputs, fabricated references, hallucinations, and difficulty tracing information sources, consistent with previous research (Bouaziz & Eddouada, 2026; Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025; Nicholas et al., 2024; Watermeyer et al., 2024). Such failures are especially consequential in doctoral research, where evidence must be verifiable and disciplinary claims defensible. The novice participant who had not encountered inaccuracies also highlights a governance problem: users may interpret an absence of detected errors as evidence of reliability. Training should therefore address how fluent outputs can conceal weaknesses, not only how to correct visible errors.

The findings on overreliance add a developmental dimension to existing concerns about weakened originality, critical thinking, and independent judgment (Dang et al., 2024; Hoomanfar & Shamsi, 2025; Ma et al., 2026; Nguyen, Ilesanmi, et al., 2024). Participants viewed dependence as a threat to the long-term formation of researchers, not only to the immediate quality of outputs. At the same time, one participant recognized and reduced an initially substitutive pattern of use, showing that dependence is not necessarily fixed. Critical GenAI literacy may develop through experience, but reliance on individual self-correction may produce uneven outcomes. Institutions should therefore make reflective, critical, and appropriately bounded GenAI use an explicit doctoral learning objective. In Informing Science terms, overreliance risks making the client dependent on the channel rather than strengthening the judgment required for independent scholarship.

Verification and traceability, although closely related to reliability, remain analytically distinct. GenAI outputs may appear fluent and plausible, but students still need to establish where information originated, whether cited sources exist, and whether claims are supportable. Verification should therefore be treated as a core doctoral competency rather than a technical afterthought.

Policy uncertainty also produced opposing responses. Some students may disclose their GenAI use inconsistently when institutional expectations are unclear, while cautious students may avoid legitimate assistance because they fear detection or misconduct allegations. Ambiguity therefore risks both under-regulation and unnecessary self-restriction. From an Informing Science perspective, unclear policy weakens the institutional environment because students and supervisors lack shared rules for interpreting, disclosing, and validating GenAI-supported work. Higher education institutions in Botswana may therefore consider distinguishing permitted support from inappropriate substitution rather than rely on broad warnings against AI use.

Financial constraints, unstable access, subscription barriers, and technical difficulties support concerns that GenAI may become a new axis of academic inequality (Asamoah & Amarteifio, 2025; Hao et al., 2025; Nicholas et al., 2024; Nyaaba et al., 2024). However, one participant perceived no access problem specific to Botswana, whereas others identified subscriptions, connectivity, and foreign-cur-

rency costs as barriers. These contrasting views may reflect differences in access circumstances, required functionality, connectivity, and patterns of use. Institutions should therefore not infer equitable access from the formal availability of free versions, but assess whether students can obtain the connectivity, advanced functions, and training required for meaningful use.

Participants also questioned whether externally developed systems adequately represent African and Botswana-specific contexts, supporting concerns about epistemic inequality (Asamoah & Amarteifio, 2025; Hao et al., 2025; Nyaaba et al., 2024; Pretorius et al., 2025). Although contextual mismatch was raised by a minority, its lower frequency does not necessarily indicate low importance. It may be more visible in locally specific research or under-recognized when plausible global responses are not checked against Botswana-specific evidence. Local validation is therefore important even where an output appears technically accurate.

Privacy and security were also minority concerns, but their low frequency may reflect either limited exposure to sensitive data or insufficient awareness. Institutional guidance in Botswana should explicitly address the entry of unpublished findings, personal or sensitive data, confidential institutional information, and research data into externally hosted systems.

DISCUSSION OF FINDINGS ON RESPONSIBLE GENAI INTEGRATION IN A DOCTORAL INFORMING SYSTEM (RESEARCH QUESTION 3)

Participants favored a multilayered policy approach combining individual responsibility, acceptable-use boundaries, integration into existing governance, disclosure, enforcement, educational integration, and training. This is consistent with research documenting incomplete GenAI governance and unclear acceptable-use boundaries in doctoral education (Bouaziz & Eddouada, 2026; English et al., 2026; Harding & Boyd, 2024; Hoomanfar & Shamsi, 2025). The findings also show what participants at the study institution considered workable within the Botswana context. Their emphasis on responsibility and clear boundaries may reflect a desire for certainty where institutional guidance remains unclear or incomplete, but it should not be interpreted as support for predominantly punitive governance. Calls for training, access, and educational integration indicate that participants wanted both regulation and legitimate opportunities for productive use. Through the Informing Science lens, these recommendations identify the conditions required for GenAI to function as a responsible and trustworthy informing resource.

Participants consistently emphasized that doctoral students should remain accountable for checking, interpreting, acknowledging, and taking responsibility for GenAI-supported work. Responsibility therefore extends beyond compliance to doctoral formation: GenAI may provide information or suggestions, but scholarly judgment remains with the researcher. However, emphasizing individual responsibility without adequate training, access, and supervisory guidance could shift the burden of navigating institutional uncertainty onto students. Accountability is meaningful only when institutions clearly explain what must be checked, disclosed, protected, and retained as evidence of responsible use.

Participants also wanted institutions to distinguish supportive use from excessive or inappropriate reliance. Such boundaries should clarify how GenAI can support doctoral work without replacing independent analysis, writing, or decision-making. A uniform institution-wide rule may be inadequate because the risks differ across tasks. Language correction and brainstorming do not present the same concerns as generating methodological decisions, interpreting data, or processing confidential information. Botswana institutions should therefore adopt task-sensitive guidance that distinguishes lower-risk assistance from higher-risk assistance or prohibited substitution.

Participants preferred embedding GenAI guidance within existing academic misconduct and governance structures rather than treating it as an isolated issue. This supports an incremental model in which existing integrity and governance frameworks are adapted rather than replaced (Zlotnikova, Maupong, et al., 2026). In institutions with limited policy-development capacity, adapting existing

frameworks may be more feasible than establishing a standalone policy regime. However, locating GenAI primarily within misconduct frameworks risks framing it mainly as a problem of cheating or detection rather than as a research, pedagogical, data-governance, and capacity-development issue. Governance should therefore extend across academic integrity, research ethics, data protection, supervision, assessment, and researcher development.

Participants also supported disclosure, monitoring, and consequences for misuse. However, differences in opinion between those who favored detection and sanctions and those who preferred investment in educational tools require careful interpretation. Excessive surveillance may discourage transparent disclosure and legitimate experimentation, whereas guidance without enforcement may remain ineffective. A proportionate response would connect disclosure to task-based expectations and due process rather than treat any declared GenAI use as presumptive misconduct.

The emphasis on workshops and seminars supports arguments that GenAI competence should be developed through structured training rather than assumed to emerge informally (Parker et al., 2025; Rebouças de Lira et al., 2026). Relevant competencies include prompting, verification, disclosure, privacy awareness, and context-sensitive judgment. Although training was mentioned less frequently than rules, this may reflect the immediate salience of policy uncertainty rather than the lesser importance of capacity development. Rules cannot be applied consistently without the competence required to interpret them; training should therefore accompany policy implementation.

Participants' call for educational integration further indicates that policy and pedagogy should not be separated. Governance is more likely to be effective when students have opportunities to develop critical evaluation, verification habits, and responsible-use practices (Dang et al., 2024; Nguyen, Hong, et al., 2024; Nguyen, Ilesanmi, et al., 2024; Xu & Shen, 2026). In Botswana, such integration should address unequal access, locally relevant examples, discipline-specific applications, and supervisors' responsibilities. Otherwise, it may disproportionately benefit students who already have better digital access and greater GenAI literacy.

Overall, responsible GenAI integration requires both individual and institutional action. Students must verify, acknowledge, and remain accountable for GenAI-supported work, while institutions must provide clear boundaries, disclosure expectations, monitoring, training, and integration into existing governance. Participants' contrasting accounts indicate that a uniform response would be inadequate. Some students may require basic awareness and access support, others may need discipline-specific guidance, and cautious users may need assurance that legitimate assistance will not automatically be treated as misconduct. A context-sensitive Botswana approach should therefore combine task-based rules, student and supervisor training, equitable access, privacy safeguards, local validation, transparent disclosure, and proportionate enforcement. From an Informing Science perspective, effective informing is shaped not only by the message or channel, but also by the client's judgment, the institutional environment, and the safeguards supporting responsible use.

CONCLUSION

RESEARCH CONTRIBUTION

This study examined how doctoral students in Botswana use GenAI in their research practices, the challenges they encounter, and the policy and guideline measures they consider necessary for its ethical and effective integration as part of a responsible doctoral informing system. Overall, the findings show that GenAI can support doctoral research, but that its value depends on critical evaluation, appropriate supervision, equitable access, and clear institutional governance.

The study makes four main contributions. First, it adds empirical evidence from Botswana to a literature base that remains dominated by studies from the Global North. In doing so, it provides a context-sensitive account of GenAI use in doctoral research within a developing-country setting shaped by uneven infrastructure, resource constraints, and emerging institutional guidance. Second, it shows

that GenAI's perceived value in doctoral research is strongest in idea development and literature review support, while broader uses such as data analysis and workflow integration remain more limited and cautious. Third, it demonstrates that doctoral students frame GenAI not only as a productivity tool, but also as a developmental, ethical, and governance issue. Finally, the study conceptually contributes to doctoral studies by applying the Informing Science perspective to GenAI use in doctoral research. It shows that GenAI can function as an informing resource for doctoral students, while also identifying challenges that affect informing quality, including reliability, verification, privacy, access, contextual relevance, and policy clarity. This highlights the need to understand GenAI in doctoral education through the combined lenses of scholarly formation, equity, institutional regulation and responsible informing.

PRACTICAL IMPLICATIONS

The findings have practical implications for universities, doctoral supervisors, and policymakers. For institutions, the results indicate the need for clearer and more context-sensitive guidance on acceptable GenAI use in doctoral research. Such guidance should address disclosure, verification, privacy, boundaries of use, and the relationship between GenAI use and academic integrity. Rather than relying only on restriction, institutions should combine governance with capacity building through workshops, seminars, and practical guidance for both students and supervisors. These measures would strengthen the institutional conditions under which GenAI can operate as a trustworthy and accountable informing resource.

For doctoral supervision, the findings suggest that GenAI may be most constructively integrated when it supports lower-level or preparatory tasks while supervisors retain focus on higher-level intellectual work such as conceptual framing, methodological rigor, critical interpretation, and research ethics. This implies that supervisory practice may need to adapt, not by withdrawing from the process, but by clarifying expectations and helping students develop responsible and critically reflective ways of working with GenAI. Supervisors therefore have an important role in helping doctoral students evaluate, verify, and contextualize GenAI-generated information rather than treating it as authoritative.

For the wider higher education context, the findings underline the importance of equity in GenAI integration. Access to paid tools, digital infrastructure, training opportunities, and context-relevant guidance may shape who benefits from GenAI and under what conditions. Effective integration therefore requires not only policy development, but also attention to affordability, inclusion, and institutional support.

RESEARCH LIMITATIONS AND FUTURE WORK

This study has several limitations. First, it was based on a relatively small qualitative sample of 15 doctoral students from science and engineering disciplines at one institution in Botswana. The findings therefore provide depth and contextual insight, but they are not statistically generalizable to all doctoral students or institutions. Second, the study focused on student perspectives only. It did not include supervisors, administrators, or policymakers, whose views would be important for understanding institutional expectations and governance dynamics more fully. Third, the study relied on self-reported experiences and perceptions, which may not fully capture actual patterns of GenAI use in doctoral work. Fourth, because GenAI tools and institutional responses are evolving rapidly, the findings should be interpreted as reflecting a particular moment in a changing technological and policy environment.

Future research should build on this study in several ways. Comparative studies across institutions, disciplines, and countries would help clarify how context shapes GenAI use as an informing resource in doctoral education. Research that includes supervisors and institutional leaders would provide a more complete picture of guidance, expectations, and governance challenges. Mixed-methods and

longitudinal studies could also examine how GenAI use develops over time and how it affects doctoral learning, supervision, writing practices, and research outcomes. Finally, future work should pay closer attention to the development and evaluation of doctoral GenAI competencies, including verification, disclosure, privacy awareness, critical prompting, and context-sensitive judgment, as these are likely to become increasingly important for ethical and effective doctoral research practice, as well as for responsible participation in a doctoral informing system.

DATA AVAILABILITY

The anonymized dataset and supplementary material not included in this paper are available in Figshare (Zlotnikova, Mokgetse, & Hlomani, 2026).

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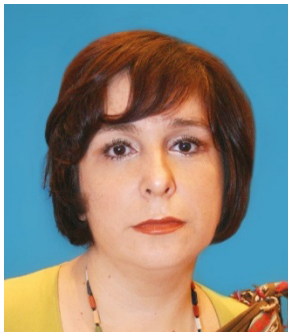
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