The impacts and tensions of generative AI on doctoral students' supervisory and peer dynamics: An activity theory analysis

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Doctoral students are increasingly adopting generative artificial intelligence (GenAI) tools in their daily academic activities. However, it remains unclear how GenAI influences doctoral training, particularly in terms of supervisory and peer interactions within PhD programmes. This qualitative study investigated the impact of GenAI adoption on doctoral students' interactions with supervisors and peers within their immediate academic environments. Guided by activity theory as the theoretical framework, we conceptualise doctoral training as an academic activity system mediated by GenAI tools within specific social and cultural contexts. Through in-depth interviews and thematic analysis, this study examined the experiences of 20 doctoral students who were early adopters of GenAI at an Australian university between June and August of 2023. Two key tensions emerged from the analysis: first, the tensions arising from the dual nature of GenAI tools, characterised by their affordances and inherent limitations; second, the conflict between productivity-oriented research practices and traditional academic norms. These tensions further triggered interpersonal tensions over differing attitudes or stances towards GenAI and conflicting expectations regarding supervisory responsibilities among students, supervisors and peers. The findings reflect evolving power relations, interpersonal dynamics and academic socialisation in the context of GenAI integration. This study offers theoretical and empirical insights for rethinking doctoral supervision and training in the GenAI era.

Implications for practice or policy:

- GenAI integration in doctoral education requires redefining the roles, responsibilities and relationships between students, supervisors and peers.
- Doctoral supervision should transition towards a more collaborative approach, emphasising co-learning, open communication and human-AI collaboration.
- Doctoral programmes need to develop clear institutional policies and structured training programmes for supervisors and students to facilitate effective GenAI use and minimise related tensions.

Keywords: generative AI, doctoral education, PhD, research supervision, peer dynamics, activity theory

Introduction

Generative artificial intelligence (GenAI) refers to AI models capable of generating new content in various formats, such as text, audio, video and code, based on their training data (Baidoo-Anu & Ansah, 2023). Due to their technical affordances, GenAI tools such as ChatGPT have been increasingly adopted by doctoral students for academic tasks, including document processing, language editing, coding and statistical analysis (Dai et al., 2023a). These tools provide timely and personalised assistance, enhancing students' research capability, self-efficacy and productivity (Fauzi et al., 2023). However, reliance on

GenAI raises significant concerns regarding academic integrity, originality and ethical issues related to data privacy and potential bias (Chan & Hu, 2023).

Despite growing adoption, the impact of GenAI tools on doctoral training remains largely unclear. Research indicates that technology integration in education is rarely linear and often involves ongoing negotiation and tensions among stakeholders (Erichsen et al., 2014). Doctoral students' engagement with GenAI is both shaped by and shapes institutional policies, academic communities and personal attitudes towards technology (Kumar & Gunn, 2024). Within this context, supervisor and peer relationships are especially critical, as these actors provide essential academic and socio-emotional support (Wang et al., 2023). Introducing GenAI as an alternative source of support may disrupt conventional relationship dynamics; however, empirical studies on these effects remain limited. Clarifying how GenAI shapes supervisory and peer dynamics is essential for developing effective strategies to support doctoral students.

Against this background, this qualitative study examined the impact of GenAI integration on interpersonal relationships in doctoral training, with a focus on supervisory and peer interactions. Guided by activity theory (AT; Engeström, 2001), we examined tensions arising from the use of GenAI in doctoral students' research practices at both individual and social levels. Conducted between June and August of 2023, this research offers a historical snapshot of the early effects of GenAI among early adopters in doctoral programmes. These findings aim to offer an evidence-based account of evolving interpersonal relationships in doctoral education and highlight potential transformations in doctoral supervision during the GenAI era.

Literature review

Doctoral education

Doctoral education is a key component of postgraduate education, equipping students with in-depth knowledge of their field's nature, language and research practices (Baker & Pifer, 2011). Doctor of Philosophy (PhD) students form a distinct subset of the doctoral cohort. Although professional doctorates are practice-oriented and focus on professional knowledge, PhD programmes emphasise academic inquiry and original contributions to disciplinary knowledge (Padró et al., 2018). Distinct from other postgraduate students enrolled in taught or research master's programmes, PhD students experience more structured and intensive academic training in their specific discipline, preparing them to independently design and undertake original research (Baker & Pifer, 2011; Lei & Hu, 2015). Additionally, unlike postdoctoral researchers who have completed formal training and focus primarily on advancing established research agendas, PhD students must first develop their scholarly identity and foundational research capabilities (Baker & Pifer, 2011; McAlpine et al., 2017). Understanding their experiences, challenges and development trajectories could provide valuable insights into how future scholars form and how disciplinary knowledge advances.

Interpersonal interactions and community engagement are critical in doctoral education because they create an environment for academic socialisation, where doctoral student researchers learn the norms, values and practices of their field (McAlpine et al., 2017; Wang et al., 2023). Doctoral students typically participate in multiple communities, including their immediate academic programmes, disciplinary networks and broader professional associations, where students interact with various actors, such as supervisors, peers, colleagues and scholars from other institutions (Baker & Pifer, 2011). Among these relationships, supervisory and peer interactions within doctoral programmes are particularly crucial, as they shape students' daily academic experiences and research progress (Lei & Hu, 2015; Lai & Dai, 2025). With the emergence of GenAI and the ongoing exploration of its potential impacts, this study (conducted between June and August of 2023) specifically focused on supervisory and peer relationships within doctoral programmes, where changes in mentoring and peer interactions are likely to be most visible and consequential.

Supervisors, as university faculty members, assist doctoral students through various stages of their studies (McAlpine et al., 2017). Their responsibilities include developing students' specialised knowledge, intellectual and technical skills and pragmatic actions, as well as familiarising students with scholarly traditions, depending on their supervisory goals (Mowbray & Halse, 2010). Through the supervisor-supervisee interaction, doctoral students not only complete their studies but also integrate into the scholarly community (Lei & Hu, 2015). This process fosters a collaborative yet individualised approach to scholarship (Baker & Pifer, 2011). However, some supervisory relationships can harbour tensions, such as hierarchical power dynamics, abandonment and inadequate supervision, which may lead to student attrition, burnout and degree discontinuation (Cheng & Leung, 2022).

In addition to supervisors, other members of the doctoral programmes, such as peers and advanced students, significantly influence doctoral students (Erichsen et al., 2014; Wang et al., 2023). These individuals are crucial resources for doctoral students facing academic challenges and uncertainties. For instance, advanced students share their research experience and strategies, while peers help each other with career decisions and offer emotional support (Baker & Pifer, 2011). This support complements formal supervision and is often more comfortable and accessible for doctoral students, particularly in high power distance societies (Wang et al., 2023). Through interactions with these scholarly members and adherence to academic norms, doctoral students progressively refine their research skills, develop expertise and transition from newcomers to independent researchers (Baker & Pifer, 2011).

Technology integration in doctoral education

Doctoral students' engagement with digital technologies has been a longstanding research topic. These technologies encompass research software such as NVivo and SPSS, AI writing tools like Quillbot and Grammarly, communication applications such as WhatsApp and Zoom, as well as social media platforms like Twitter and LinkedIn (Alghamdi & Plunkett, 2022; Dowling & Wilson, 2017). Research indicates that these technological tools benefit students' academic writing, social interactions and engagement with the academic community (Gouseti, 2017). In recent years, GenAI, especially ChatGPT, has been increasingly used by doctoral students (Dai et al., 2023a; Storey, 2023). Surveys show that approximately half of doctoral researchers use ChatGPT in research tasks, particularly for language editing, ideation, code generation and data processing (Dai et al., 2023b; Le, 2023; Van Noorden & Perkel, 2023). This indicates the significant potential of GenAI to enhance students' research efficiency and productivity (Fauzi et al., 2023).

Studies have shown that the integration of technology – particularly information and communications technology – has influenced supervisory interactions and relationships. For instance, in online doctoral programmes, timely feedback and responses from supervisors have been shown to reduce students' anxiety about conducting research and completing their dissertations (Bolliger & Halupa, 2012). However, some students in distance education programmes struggle to connect with their supervisors and academic departments, feeling isolated and forgotten, while some supervisors find it challenging and time-consuming to adapt to new technologies (Erichsen et al., 2014). These issues highlight the complexity of supervisory dynamics in mediated environments, where tensions can arise due to the integration of technology.

Peer relationships of doctoral students are also shaped by various technological tools. For example, videoconferencing platforms such as Zoom, Microsoft Teams and Google Meet facilitate online collaborative writing, foster networking opportunities and enhance commitment to scholarly activities among doctoral students (Subedi et al., 2022). Additionally, communicative tools such as email and mobile messaging applications like WhatsApp are commonly used by doctoral students to connect and collaborate with their fellow students (Gouseti, 2017). Despite these advancements, some doctoral students engaged in distance learning programmes have reported feelings of isolation and a lack of community, which can weaken their connections with peers (Erichsen et al., 2014). This perceived disconnect may further lead them to undervalue the importance of peer interaction in achieving their academic goals.

Conversely, interpersonal relationships have a significant influence on student engagement with technology. For example, some students regard guidance from their supervisors as the initial step in adopting digital tools and often receive hands-on assistance from peers skilled in technology use (Gouseti, 2017). Additionally, students' attitudes and intentions towards technology adoption are shaped by their supervisors and peers (Dowling & Wilson, 2017). If supervisors are sceptical or unfamiliar with digital research and communication, doctoral students may hesitate to utilise or may limit their adoption of technology in their studies. Consequently, the beliefs and acceptance of technology among community members can subtly influence those of students.

GenAI, as an emerging technology, has the potential to impact the supervisory and peer relationships of doctoral students. Dai et al. (2023a) found that GenAI enables students to participate in more advanced discussions with their supervisors by assisting with routine queries and basic research tasks. This transformation may enhance the quality of academic mentorship, leading to more intellectually stimulating supervisory meetings and peer collaboration (Storey, 2023). However, challenges remain, such as a potential erosion of trust in the student-teacher relationship and increased expectations placed on educators (Luo, 2024). So far, there is a lack of empirical studies examining the interplay between GenAI integration and doctoral students' interpersonal relationships, as well as the challenges it poses to doctoral training. Therefore, we proposed the following research questions:

(1) How does the integration of GenAI in doctoral training impact supervisory and peer interactions of doctoral students who are early adopters of GenAI?
(2) What tensions does the GenAI integration bring to these interpersonal relationships within doctoral education programmes?

Theoretical framework: AT

AT provides a theoretical and analytical framework for examining the impact of GenAI tools on doctoral experiences (Engeström, 1999; Leont'ev, 1974; Vygotsky, 1978). AT facilitates the understanding and analysis of human activity at both individual and social levels (Engeström, 1987; Gedera et al., 2023). The theory posits that human activity can be described and analysed as a structure under specific conditions, which is also mediated by particular tools to achieve a purpose (McAvinia et al., 2016). AT originated from Vygotsky's mediated action triangle, which outlines the structure of a *mediated act* (Vygotsky, 1978; Wertsch, 1985). Over time, it has evolved from an individual-centric to a collective activity system (Figure 1), which serves as a fundamental and meaningful unit for analysis (Engeström, 2001).

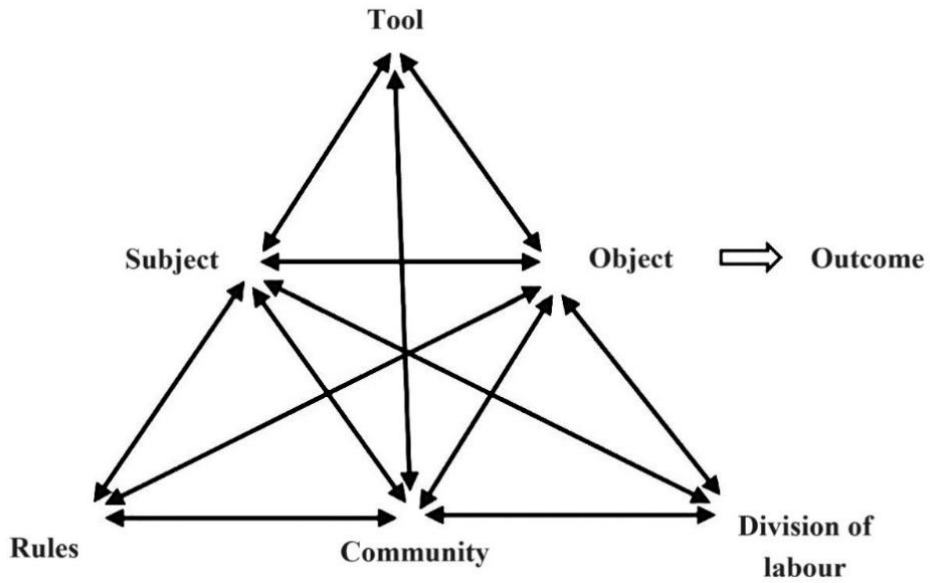

Figure 1. Activity system (adopted from Engeström, 2001, p. 135)

An activity system consists of six elements. According to Hopwood and Stocks (2008), the subject, or the human agent, refers to the individual or group engaged in the activity, while the object represents the purpose of that activity. The mediating artefact includes tools or signs that facilitate the achievement of the object. Additional elements – rules, community and division of labour – illustrate the transition from individual actions to collective activity. In this context, rules represent the norms, practices and expectations that guide the actions of human agents; community refers to participants, other than the subject, who share the same object and outcomes of the activity; and division of labour denotes the roles, tasks and responsibilities distributed among community members (Hopwood & Stocks, 2008). Once the object is achieved, it transforms into an outcome that reflects the results or consequences of the actions taken.

At the heart of AT is the principle of contradictions – systemic and inherent conflicts within or between different elements of an activity system (Engeström, 2001). Contradictions represent historically accumulated structural tensions in people's routines and practices (Engeström, 2001; Hopwood & Stocks, 2008). These contradictions are not merely problems or obstacles; instead, they are viewed as sources of change and development within the system (McAvinia et al., 2016). The concept originates from dialectical materialism and is essential for understanding how activity systems evolve. Four hierarchical contradictions exist within activity systems: primary, secondary, tertiary and quaternary (Engeström, 1987; Gedera et al., 2023). The primary contradiction stems from Marx's discussion of the tension between value and wealth in capitalism (Engeström, 1987). It occurs within a single element and often serves as the seed for subsequent contradictions (McAvinia et al., 2016). Secondary contradictions arise between the elements within a system; tertiary contradictions emerge when new methods are employed to achieve the object, leading to internal conflicts within the activity, such as the introduction of technology; and quaternary contradictions involve changes to an activity that conflict with other activities (McAvinia et al., 2016).

AT has been used to investigate technology integration in postgraduate education, such as the adoption of digital learning tools during the COVID-19 pandemic (Gedera et al., 2023) and interactions via social networking sites (Alghamdi & Plunkett, 2022). In the context of integrating GenAI into doctoral training, AT provides a robust framework for examining doctoral students' technology adoption and the interplay between GenAI tools and supervisory and peer relationships. Guided by AT, we adapted a model for this study (see Figure 2), with the ultimate goal of doctoral training within this activity system. This model examines how subjects, tools and community-related factors interact and influence one another, revealing the emerging adaptations, tensions and outcomes associated with the integration of GenAI in doctoral education.

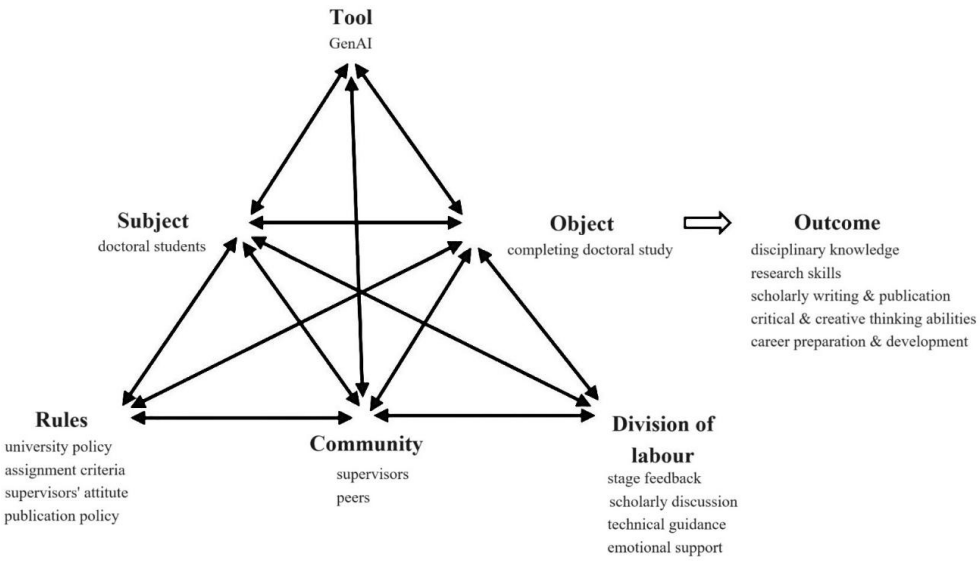

Figure 2. An AT lens to analyse GenAI's impact on doctoral students' interpersonal relationships

Research methods

Research contexts and participants

To ensure representativeness, 20 PhD students were recruited from a research-intensive university in Australia. At the time of data collection, this university had issued official guidelines supporting the integration of GenAI tools by faculty and students. Overall, it encourages students to adopt GenAI tools in a transparent, responsible and ethical manner. We (the authors) adopted convenience sampling, snowball sampling and purposeful sampling for participant recruitment (Merriam & Tisdell, 2016). Internal recruitment emails were sent to potential participants, who were also encouraged to invite other eligible candidates. Additionally, recruitment posts were shared in the university's PhD students group chats on social media platforms.

The sampling criteria were as follows: (a) participants should have more than 3 months of experience using free or paid ChatGPT service in research; (b) the gender ratio should be 1:1; (c) participants should represent various specialised domains, including arts, social sciences and science, technology, engineering and mathematics; and (d) participants should be at different stages of their studies. The rationale for these criteria is as follows: (a) ChatGPT is a representative example of GenAI, and participants with sufficient experience using it in research would provide valuable insights into its use in research; (b) an equal gender ratio minimises bias from a predominance of one gender; (c) diversity in specialised domains offers insights into the different ways doctoral students utilise ChatGPT; (d) variation in stages of study helps to identify the dynamic of interactions within the academic community. Information about the participants and their supervisors is presented in Table 1.

Table 1
Information about participants and their supervisors

No.	Field	Gender	Attitude towards GenAI	Supervisor's attitude towards GenAI
1	Chemical Engineering	F	Positive	Neutral
2	Computer Science	M	Neutral	Neutral
3	Computer Science	M	Neutral	Neutral
4	Computer Science	M	Neutral	Positive
5	Electrical Engineering	M	Positive	Negative
6	Environmental Science	M	Neutral	Positive
7	Mechanical Engineering	M	Positive	Positive
8	Mechanical Engineering	M	Positive	Positive
9	Mechanical Engineering	M	Neutral	Neutral
10	Mechanical Engineering	F	Neutral	Positive
11	Industrial Design	F	Positive	Positive
12	Precision Processing Technology	F	Neutral	Neutral
13	Robotics	M	Positive	Positive
14	Art & Design	F	Neutral	Neutral
15	Education	F	Neutral	Negative
16	Law	F	Positive	Positive
17	Law	M	Positive	Neutral
18	Linguistics	F	Negative	Negative
19	Marketing	F	Positive	Positive
20	Real Estate	F	Positive	Negative

Note. M represents male and F represents female. Students' and supervisors' attitudes towards GenAI were derived from students' self-reports.

Data collection

This study adopted a qualitative research design (Merriam & Tisdell, 2016). Data were collected through participant interviews and chat histories with ChatGPT. Each interview comprised two parts: a semi-structured interview and a stimulated recall interview. The semi-structured interviews served as the primary data collection method, focusing on students' perspectives regarding how the adoption of ChatGPT influenced their doctoral training, the challenges and tensions it presented and potential solutions. The stimulated recall interview supplemented this by examining specific scenarios in which students had used ChatGPT for research and cross-checking the consistency of their responses and behaviours.

Before the interview, we requested that all participants provide at least five chat histories with ChatGPT. Each chat should be generated in the context of their day-to-day research practice and include a minimum of five rounds of interaction focusing on a single academic task. We reviewed all chat histories before the interviews to familiarise ourselves with the content and to design tailored questions for each participant. To enhance the objectivity and trustworthiness of the study, we developed the interview protocols based on the adapted AT framework (Figure 2). We conducted pilot interviews with five doctoral students to validate the coverage and relevance of the proposed interview protocol. Based on their feedback, we revised the interview questions before conducting the formal interviews. Each interview lasted approximately 1.5 to 2 hours, and informed consent was obtained prior to the interview. Four out of the 20 students expressed discomfort with audio recording; therefore, we manually took detailed notes during their interviews to ensure data accuracy. The interviews with the remaining 16 students were audio-recorded and transcribed verbatim.

Data analysis

We employed reflexive thematic analysis, supplemented with grounded theory techniques for data analysis (Braun & Clarke, 2021; Corbin & Strauss, 1990). First, we iteratively read the interview transcripts to familiarise ourselves with the data. We then conducted line-by-line open coding to generate initial descriptive codes that captured specific experiences and interactions related to the integration of GenAI in doctoral supervision. The six elements of the activity system served as conceptual lenses, guiding the organisation of these codes into preliminary categories ("buckets"). We continuously tested the relationships and distinctions among the open codes. Codes with shared meanings or patterns – such as perceived affordances and inherent limitations of GenAI, and the varying attitudes of different stakeholders toward its integration into research practices – were grouped into axial codes. These axial codes underwent constant comparison and refinement, ultimately forming higher-level themes that encapsulated the contradictions introduced by GenAI in doctoral training.

Theoretical memos were consistently written throughout the coding process to reflexively formulate and revise the codes and themes (Corbin & Strauss, 1990). To ensure consistency in coding, we assessed inter-rater reliability, achieving a coding agreement of 88%. Any discrepancies during the coding phases were resolved through discussions among us until a consensus was reached (Braun & Clarke, 2021). To enhance the credibility and rigour of the findings, we employed data triangulation (interviewing different students), methodological triangulation (combining interviews and document analysis) and investigator triangulation (involving several of us in the coding process), as outlined by Denzin (2015).

Findings

The analytical results are organised into three subsections. According to AT, the primary contradiction is often the most fundamental and can trigger other contradictions (McAvinia et al., 2016). This contradiction is inherent in the elements of the activity system, as each element may possess its own conflicting needs and interests. Therefore, we begin by identifying the primary contradictions, the duality of GenAI tools and academic norms, which are most salient and relevant in triggering other types of

contradictions in doctoral training. Building on these primary contradictions, we discuss the impact of GenAI integration on supervisory and peer dynamics within the community.

Duality of GenAI tools and respective academic norms

By analysing the data collected in 2023, we identified two sets of primary contradictions within the elements of the tool and rules. Each contradiction shows a duality within its respective element – two conflicting aspects of the same phenomenon (see Table 2).

Table 2
Primary contradictions

Element	Contradictory aspect 1	Contradictory aspect 2
Tool (GenAI tools)	Affordances: - providing timely feedback - searching for and processing literature and materials - programming - editing writing - ideating - drafting emails	Limitations: - lack of authenticity and accuracy - lack of domain-specific, experience-related and in-depth knowledge - lack of originality and creativity - lack of emotion and sociability - lack of data security
Rules (academic norms)	Productivity-oriented research practices: - improved efficacy and streamlined workflow - an emphasis on research productivity - broad and general arguments that represent layman understanding	Traditional academic norms: - originality and integrity - depth of research and engagement - strict adherence to research protocols - accuracy and reliability of research processes

The primary contradiction within GenAI tools arose from their dual nature – affordances and inherent limitations in functionality. When adopting GenAI tools for academic activities, students enhanced research capabilities and streamlined workflows but faced challenges due to the limitations of GenAI models. For instance, students frequently mentioned the tool's ability to provide timely feedback, which supervisors could not always offer. However, they also noted GenAI's lack of domain-specific or in-depth knowledge, an area where supervisors excelled. This observation is particularly relevant during the early stages of adoption in 2023. These examples show that doctoral students often compare GenAI with their supervisors, compensating for the limitations of one with the strengths of the other.

Another set of primary contradictions existed within the element of rules, stemming from the tension between traditional academic norms in which students were trained and productivity-oriented research practices resulting from the GenAI integration. When GenAI tools such as ChatGPT were publicly launched, most participating students had already received specific academic training that emphasised originality, deep engagement with research topics and strict adherence to the reliability and reproducibility of research outcomes. However, with the introduction of GenAI tools, the students encountered new expectations that often conflicted with their initial training. For instance, although GenAI could assist in generating literature reviews and suggesting research directions, students had to ensure that their work remained original and did not rely too heavily on AI-generated content. Furthermore, the ease of access to vast information provided by GenAI tools sometimes challenged students' in-depth engagement in research projects. These conflicts hindered students from fully embracing GenAI tools in their academic workflows.

Contradictions in supervisory relationships

Different attitudes and actions towards GenAI tools

The duality in tools and norms further led to a secondary contradiction between students and supervisors. Student interviews reveal that, although the adoption of GenAI in research is becoming a trend in doctoral studies, supervisors demonstrate varying attitudes towards this trend. A total of 45% of these supervisors were positive and supportive of integration, while others were more cautious or reserved. This divergence stems from the dual nature of GenAI and the conflicts between emerging research trends and traditional research norms. According to nine students, their supervisors were open-minded and even radical in embracing GenAI tools, recognising the potential of GenAI tools to enhance the research process. These supervisors viewed GenAI as an opportunity for students to develop cutting-edge skills that are increasingly relevant in modern academia and industry.

In contrast, 11 out of 20 supervisors held cautious or negative attitudes towards GenAI, focusing on its limitations and the challenges it posed to traditional research practices. Although these supervisors had varying reasons for opposing GenAI tools, they shared common concerns about the implications for academic integrity and quality of academic work. One major concern was that over-reliance on GenAI tools could lead to superficial engagement with research topics, thereby diminishing the necessity for critical and in-depth thinking. These supervisors emphasised the importance of deep and hands-on engagement with literature and data, which they believed is essential for developing a thorough understanding of the subject matter. They feared that students might accept AI-generated content without sufficient scrutiny or critical analysis. Additionally, two supervisors expressed apprehension about disrupting established research methodologies that have proven effective over time. These differing expectations, understandings and approaches to research and academic integrity resulted in conflicting viewpoints between students and supervisors. One student complained:

> My supervisor is more of a traditional, old-fashioned, Soviet-style educator. He doesn't want to and doesn't like to use [ChatGPT] ... He tends to dismiss new technologies, such as machine learning, and has no interest in exploring them … He wondered why he should use these "strange tools" when traditional mathematical theories can adequately solve the problems.

This interview reveals that some supervisors are resistant to change, prefer traditional approaches and are sceptical about the benefits of new technologies. Due to the unequal power dynamics, students found it difficult to influence their supervisors' views or address their concerns, given their less authoritative position. Consequently, they resorted to using GenAI secretly, which exacerbated misunderstandings and strained supervisory relationships. Additionally, students reported a lack of support from their supervisors in navigating the challenges associated with GenAI use, as many supervisors held conservative views and lacked AI literacy. This tension stemmed from a primary contradiction within the element of rules. Without proper guidance, students faced the dilemma of whether to follow the emerging research trends or adhere strictly to the traditional academic norms. Ultimately, they had no choice but to explore the boundaries and possibilities of GenAI independently, which hindered their ability to improve their learning and research efficiency.

Changing expectations for the supervisors

As GenAI has been increasingly integrated into research projects, the division of labour between students and supervisors has changed. Due to the duality of the GenAI tool, more than half of the students mentioned that they tended to leverage its strengths, such as immediate support and open discussion, to compensate for the guidance they received from supervisors. For example, three students noted that they valued GenAI's timely feedback, which made them feel more comfortable and confident in their interactions. They perceived ChatGPT as fostering a closer and more equal relationship than their supervisors. Moreover, seven students mentioned the exciting ideas that emerged during discussions with ChatGPT. In these aspects, students believed that GenAI could potentially fulfil specific roles of their supervisors. Despite this, students also acknowledged the limitations of GenAI, such as its lack of high-level support, emotion and sociability, and expressed a desire to receive support from their supervisors.

As students used GenAI in research, they constantly compared it with their supervisors, leading to evolving views and expectations regarding their supervisors' roles and responsibilities.

Among students dissatisfied with their supervisors, reliance on GenAI diminished the perceived value and significant role of supervisors. Seven students reported that they turned to ChatGPT for assistance more frequently and prioritised consulting it for academic inquiries. One student remarked, "There is no need to discuss these issues with supervisors". Another student claimed that she had "a closer relationship with ChatGPT" and even believed that "ChatGPT knows more than a co-supervisor". This shift was particularly evident among students who already had a strained relationship with their supervisors. One student explained, "My supervisor quickly loses his patience and even calls me dumb, so I hesitate to ask too much ... With ChatGPT, I can ask whatever I wish and whenever I want". In this case, ChatGPT appears to be a beacon for those feeling lost, providing essential guidance and emotional support.

However, the over-reliance on ChatGPT has obscured the significance of the roles and assistance provided by supervisors, intensifying tensions in supervisor-supervisee relationships. Such a weakened supervisory relationship and lack of mentorship may hinder students from engaging in in-depth discussions with academics and actively participating in the academic community. These dynamics risk isolating students from valuable academic discourse and the mentorship necessary for their intellectual growth.

Moreover, despite students' expectations of their supervisors, such as more in-depth project-related discussions and support for emotions and sociability, many supervisors were unable to meet these evolving needs. Specifically, as ChatGPT accelerated their research progress, four students expressed a desire for more frequent discussions with their supervisors. They sought personalised support, including problem-solving specific to their research projects, guidance tailored to their experiences and detailed feedback on their manuscripts. Beyond skill development, students also yearn for human-related support from their supervisors that ChatGPT cannot provide, such as assistance with community engagement and emotional support. One student expressed appreciation for the daily work updates shared by his supervisor:

> At our group meetings, my supervisor often shares his activities from the previous week, including the meetings he attended, the people he met and the grants he applied for. This could potentially inspire me and open up collaboration opportunities ... He discusses his daily routine from the perspectives of both a doctoral graduate and a faculty member. As I lack such experience, I'm interested in his sharing – it offers a glimpse into the routines I might take on if I pursue an academic career.

However, three supervisors continued to adhere to traditional supervision methods. For instance, they addressed specific technical issues during weekly group meetings or delegated manuscript revisions to senior students or postdoctoral researchers. Consequently, students expressed dissatisfaction with the limited research efficiency and quality of supervision. Additionally, due to their busy schedules, supervisors were unable to meet students' demands for more frequent discussions. These constraints highlight a secondary contradiction between the use of GenAI and the division of labour within the academic community. Resolving these issues becomes even more challenging, particularly when students are not encouraged to utilise GenAI.

Contradictions in peer relationships and lab environments

Different stances towards GenAI tools and peer learning

Similar to the supervisors, the duality of the GenAI tool led to varying stances on its adoption among students and their peers. However, this variation was less pronounced compared to that observed among supervisors, and student resistance to GenAI was less entrenched. According to the interviewed students, their peers often emerged as significant influencers in shaping their behaviours and attitudes towards GenAI. For instance, one student recounted learning prompting strategies, such as "assigning ChatGPT a role", from a peer specialising in computer science during everyday conversations. This peer-to-peer

knowledge transfer highlights the informal yet critical pathways through which technical expertise is disseminated within student communities.

Another student with a positive attitude towards ChatGPT described her efforts to introduce the tool to her peers. She hoped to "make progress with AI" but recognised the scepticism among some colleagues, who often criticised ChatGPT's responses. Thus, she endeavoured to persuade them of ChatGPT's usefulness through arguments and demonstrations. She recalled:

> Some peer researchers may come across as somewhat proud and arrogant. They believe that AI can't replace us …They complained that whenever they asked ChatGPT for a solution, it provided useless or incorrect answers. However, in my view, the quality of its responses depends on how the questions are posed. So, I drafted some prompts for them, and then they used [these prompts] to restart their conversation with ChatGPT. This might serve as an inspiration [for them], as they then experimented with other prompts with ChatGPT.

Her attempts to persuade her peers suggest a complex interplay between individual agency and collective acceptance in academic settings. This dynamic indicates that students do not merely passively receive peer influence; instead, they actively engage in shaping the collective stance towards emerging technologies.

The lab environment is also a significant determinant of students' attitudes and acceptance of GenAI. One student who incorporated ChatGPT into his daily research noted, "ChatGPT is running on almost every computer in my lab". His enthusiastic adoption, driven by recommendations from his lab mates, illustrates the influential role of local academic cultures in familiarising individuals with new technologies. Conversely, another student approached ChatGPT with caution, influenced by her lab mates' reservations about its limitations. These contrasting experiences demonstrate the importance of the immediate social environment in mediating technology adoption. The findings suggest that, compared to supervisors, students are more susceptible to peer influence in adopting new technological tools. This peer influence can either facilitate or hinder adoption, depending on the prevailing attitudes within specific academic subcultures.

Impacts on peer relationships

Changes and tensions emerged in peer interactions, particularly among colleagues working on the same research projects or in the same labs. Four students reported a decrease in task-related interactions with peers due to the assistance provided by GenAI. Two of them asserted that this reduction did not negatively affect their relationships, as they maintained bonds with supervisors and colleagues through communal activities, such as regular meetings, shared meals and social gatherings. However, two students perceived the adoption of GenAI as a risk that could diminish opportunities for meaningful conversations. These task-related interactions often extended beyond immediate content, serving as vital platforms for exchanging perspectives, unexpected insights and collaborative opportunities. As one student vividly put it, "During idle chatter, bang, inspiration strikes". Therefore, although the ease and immediacy of GenAI tools offered certain advantages, they also risked reducing instances where students sought human advice or collaboration, potentially leading to a decline in the depth and richness of discussions.

Multiple students expressed a growing preference for GenAI tools over peer assistance. Notably, students with negative sentiments towards their lab environments expressed more complex feelings regarding this shift. Two students even attributed more value and respect to technology than their peers. One student who described his experience in a "toxic lab" reflected:

> I feel relieved and less bothered by my lab mates … Talking with ChatGPT is much easier; it's always supportive, trying to help me solve my problems rather than blaming me … However, this [the reduced interaction] is not caused by ChatGPT. I hadn't experienced much constructive collaboration before, as they often told me I was wrong and not smart

> enough. At least now, I can make progress on my project ... My priority now is to complete my dissertation and leave this lab.

The student's account reveals a complex dilemma stemming from reliance on GenAI tools, especially in unsupportive environments. On one hand, these tools offered an alternative source of peer support, alleviating stressful interactions and providing mental relief to students. The independence afforded by GenAI tools provided a buffer against the negative aspects of their work environment. On the other hand, this reliance may encourage a shift away from peer interaction, potentially overlooking the importance of such interactions for academic growth. Consequently, feelings of detachment and isolation among students could be exacerbated. In this context, the integration of technology within the academic community has amplified existing issues, bringing underlying concerns to the forefront.

Conclusion and discussion

This study investigated the impact of doctoral students' adoption of GenAI on their interpersonal dynamics with supervisors and peers in the academic community. Using AT as the theoretical framework, we identified two levels of tension: primary contradictions within the elements of the tool and rules, and secondary contradictions among the subject, community and division of labour arising from the primary contradictions. In supervisory relationships, the dual nature of GenAI tools and academic rules led to differing attitudes between supervisors and students, resulting in inadequate guidance regarding students' adoption of GenAI. Although GenAI tools replaced some of the supervisory support, student expectations of the supervisors' role and responsibility evolved, but this shift was not consistently recognised and addressed by supervisors. Different stances towards GenAI also existed among supervisors and students, with the latter exhibiting more adaptability than the former. Additionally, task-related discussions diminished among peers, potentially exacerbating interpersonal tensions. These findings offer theoretical and practical implications for doctoral education.

Theoretical implications of doctoral education research

This study shows that GenAI is not merely a research tool but a reflection of the evolving research practices among doctoral students. By accelerating information processing and routine tasks, GenAI streamlines workflows and enhances research efficiency (Fauzi et al., 2023). This development aligns with broader academic trends that prioritise efficiency, productivity and measurable outcomes, such as publication counts and impact factors, as indicators of scholarly success (Horta & Li, 2022; Lee, 2012). These shifts signal a deeper theoretical change in doctoral education, where traditional, apprenticeship-based models are being reshaped by technological advances (Dai et al., 2023a). GenAI exemplifies this change by influencing mentoring, collaboration and community engagement, while raising critical questions about academic integrity, authorship and identity (Chan & Lee, 2023; Duah & McGivern, 2024). Consequently, these developments challenge existing theories of doctoral supervision and urge an updated conceptual framework that considers how GenAI shapes doctoral students' scholarly development, interactions and knowledge production.

The shifting roles and division of labour uncovered in the study suggest a new doctoral training model (Figure 3). This model builds on Dai et al.'s (2023a) AI-enhanced postgraduate research supervision model, which outlines the evolving roles and responsibilities of supervisors and students. Characterised by tetradic interactions among students, GenAI, supervisors and peers, this model sheds light on the changing power dynamics within the broader context of doctoral training. Traditionally, supervisory relationships have positioned supervisors as primary authorities on knowledge, guiding students' attitudes and research practices (Dowling & Wilson, 2017; Wang et al., 2023). However, the integration of GenAI redistributes authority, empowering students to solve problems independently. A parallel shift also emerges in peer interactions. Although GenAI allows doctoral students to rely less on advanced peers for research support, an increasing dependence on GenAI may reduce meaningful intellectual exchanges among peers (Baker & Pifer, 2011). This reduction could hinder rich scholarly dialogue and collaborative knowledge construction (Chan & Hu, 2023).

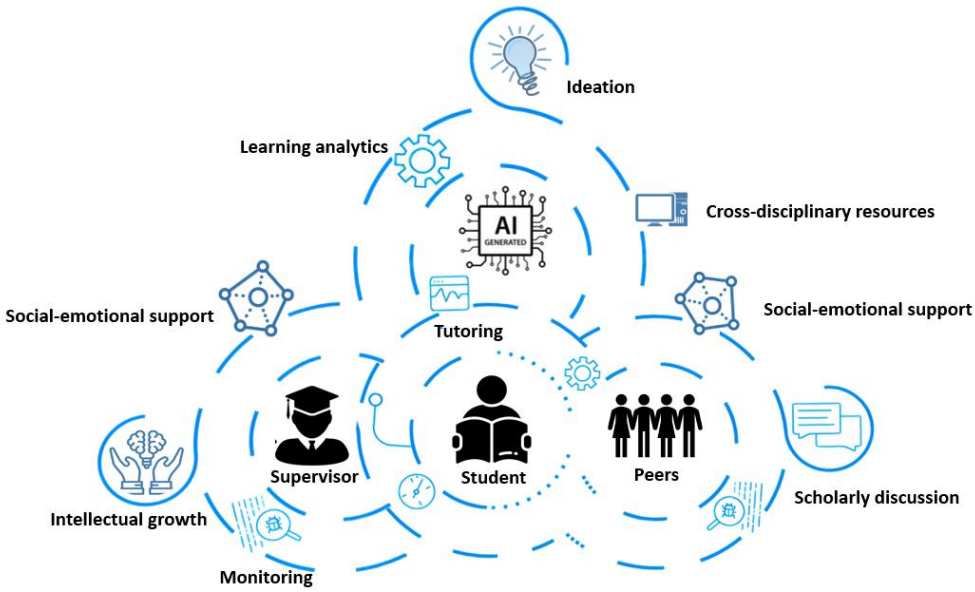

Figure 3. An evolving model of doctoral training

The findings highlight the complexity and evolving dynamics of technology adoption in higher education. By August of 2023, supervisors appeared more reluctant to accept GenAI in research compared to doctoral students, consistent with AT's perspective that historical experiences shape current stances (Gedera et al., 2023). As established scholars, many supervisors have internalised traditional academic norms and thus often advocate maintaining established practices. In contrast, doctoral students, navigating an increasingly competitive academic landscape, show greater openness to integrating GenAI into their research activities. This divergence aligns with the technology acceptance model, which suggests that the acceptance of technological innovations, such as GenAI, depends largely on perceived usefulness and ease of use, influenced by prior experience and familiarity with technology (Chan & Lee, 2023). Additionally, students' varied attitudes challenge the assumption of extensive self-initiated use of GenAI, highlighting the need for more context-specific research into this phenomenon (Dai, 2025).

Practical implications of doctoral training

In response to the challenges that GenAI brings to doctoral supervision, both top-down and bottom-up transformations are necessary. From a top-down perspective, universities and programmes should establish explicit policies and guidelines regarding the use of GenAI (Dai et al., 2024). Such policies can help reduce biases against GenAI and prompt its effective use among researchers. Moreover, professional training on AI literacy, delivered through workshops or seminars, should be organised for students, faculty and staff (Cha et al., 2024). From a bottom-up perspective, supervisors need to adapt their roles and responsibilities to meet students' needs by providing high-level guidance and facilitating academic socialisation among students and peers. Furthermore, supervisors and policymakers should regularly collect student feedback and use it for evidence-based policymaking.

Research findings also suggest the development of new supervisory platforms that integrate GenAI with social networking functions and AI boundary conditions. Sole reliance on GenAI can lead to isolation, diminishing communication with supervisors and peers, as well as overlooking the impact of networking and sociocultural factors on academic and identity development (Baker & Pifer, 2011). However, integrating social networking functions into GenAI platforms can enhance students' academic socialisation (Gouseti, 2017). Additionally, developing GenAI with boundary conditions, such as fine-tuning it to specific high-quality research data sets, can provide students with more accurate and in-depth research information (Chaturvedi & Rodriguez, 2023). This approach calls for more interdisciplinary studies that take student perspectives and needs into account in system and programme development (Green et al., 2019).

Limitations and future studies

This study has several limitations. First, the sample was limited to 20 doctoral students from a research university in Australia. Second, data collection relied solely on student interviews, omitting the perspectives of supervisors and peers. Third, although the AT framework focused on students' everyday interactions within academia, it overlooked the influence of GenAI on their engagement with individuals in the online community or outside the academic community. Furthermore, as GenAI is an emerging tool with evolving capabilities, this study offers only a snapshot of its early adoption and impacts. Future research could benefit from a longitudinal investigation with a more diverse sample.

Author contributions

Sichen Lai: Conceptualisation, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review and editing; **Suya Liu**: Data curation, Investigation, Writing – review and editing; **Yun Dai**: Conceptualisation, Investigation, Formal analysis, Writing – review and editing, Supervision; **Cher Ping Lim**: Writing – review and editing; **Ang Liu**: Data access, Writing – review and editing.

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