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Cognitive Representations of Generative AI among Pre-Service Teachers: A Phenomenological Study in a Teacher Education College in Karachi

Sharjeel Ahmed[1], Aoun Ali[2] & Muhammad Talha Mansoor[3]

[1]*Lecturer, Department of Education, Govt. College of Education Federal B Area, Karachi, Pakistan, Email: sharjeel@gce.edu.pk*
[2]*Lecturer, Department of Psychology, Govt. College of Education Federal B Area, Karachi, Pakistan, Email: aoun.ali@gce.edu.pk*
[3]*Lecturer, Department of Computer Science, Govt. College of Education Federal B Area, Karachi, Pakistan, Email: talha@gce.edu.pk*

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Corresponding Author:
Sharjeel Ahmed
Email:
sharjeel@gce.edu.pk

ABSTRACT

The rapid integration of Generative Artificial Intelligence (GAI) in education has significantly influenced how future educators perceive teaching, learning, and professional practice. This phenomenological case study explores the cognitive representations of Generative AI among pre-service teachers enrolled in a public sector teacher education college in Karachi, Pakistan. Semi-structured interviews were conducted with 26 pre-service teachers, and the data were analysed thematically to capture participants' lived experiences, metaphors, and meaning-making processes related to Generative AI. The findings reveal that pre-service teachers cognitively represent Generative AI through humanised metaphors such as a helping hand, teacher, friend, and guide, reflecting its perceived supportive and facilitative role in learning and academic work. At the same time, participants expressed concerns regarding over-dependence, cognitive decline, reduced creativity, and the potential weakening of critical thinking skills. The study further highlights a conditionally optimistic outlook toward the future of education, with participants emphasizing that the benefits of Generative AI are contingent upon ethical, balanced, and reflective use. These findings underscore the need for teacher education programs to integrate critical AI literacy, ethical awareness, and reflective pedagogical practices to support responsible and meaningful engagement with Generative AI.

Introduction

The rapid advancement of Generative Artificial Intelligence (GAI), particularly large language models (LLMs) such as ChatGPT, has significantly transformed contemporary educational practices (Garzón et al., 2025; Kohnke & Zou, 2025; Kofinas et al., 2025). Generative AI refers to systems capable of producing human-like text, ideas, and explanations based on user prompts, thereby enabling new forms of interaction, content generation, and knowledge mediation. In higher education, these tools are increasingly used for academic writing, lesson planning, conceptual clarification, and instructional support, raising both opportunities and concerns for teaching and learning processes (Kasneci et al., 2023).

Teacher education programs occupy a critical position within this evolving landscape. Pre-service teachers are not only users of Generative AI but also future classroom practitioners whose beliefs and understandings will shape how these technologies are integrated into schooling. Existing research suggests that educators' perceptions of AI range from optimism regarding efficiency and innovation to anxiety about dependency, ethical misuse, and erosion of critical thinking (Zhai, 2022; Garzón et al., 2025). However, much of this research has focused on attitudes, readiness, or perceived usefulness, often through survey-based methodologies. Such approaches provide limited insight into how pre-service teachers internally conceptualize and make meaning of Generative AI within their lived academic experiences.

Statement of the Problem

Despite the growing use of Generative AI in teacher education, there is a notable lack of research exploring the cognitive representations that pre-service teachers hold about these technologies. Cognitive representations, comprising mental models, metaphors, beliefs, and interpretive frameworks, play a decisive role in shaping how individuals engage with new technologies and how they envision their professional roles (Ahmed et al., 2024). In the context of Generative AI, these representations influence whether pre-service teachers perceive AI as a supportive tool, a collaborator, a threat to professional identity, or a replacement for human teaching. This gap is particularly evident in public sector teacher education institutions in Pakistan, where students often operate within resource-constrained environments while simultaneously navigating rapid technological change. In cities like Karachi, pre-service teachers enrolled in public sector colleges increasingly rely on Generative AI for academic support, yet little is known about how they cognitively interpret this reliance or how it shapes their understanding of teaching, learning, and professional responsibility. Without such insights, teacher education programs risk addressing AI only at a technical level, overlooking deeper epistemological, ethical, and identity-related dimensions.

Purpose of the Study

The purpose of this study is to explore the cognitive representations of Generative AI among pre-service teachers enrolled in a public sector teacher education college in Karachi. Using a phenomenological case study approach, the research seeks to capture participants' lived experiences, metaphors, beliefs, and meaning-making processes related to their engagement with Generative AI in academic and professional contexts.

Research Questions

Guided by phenomenological inquiry, the study is driven by the following research questions:

1. How do pre-service teachers in a public sector teacher education college in Karachi cognitively represent Generative AI?

2. How do these cognitive representations shape pre-service teachers' perceptions of their professional roles and the future of education?

These questions are intentionally broad and exploratory, allowing participants' lived experiences and subjective meanings to emerge organically from the data. This research is situated in a public sector teacher education college in Karachi, one of Pakistan's largest metropolitan centres. Public sector colleges play a vital role in preparing teachers for government and low-resource schools, making them a critical site for examining how emerging technologies are understood and negotiated. Exploring pre-service teachers' cognitive representations of Generative AI within this context provides valuable insights into how global technological developments intersect with local educational realities.

Literature Review

Generative Artificial Intelligence in Education

Artificial Intelligence (AI) in education has evolved from rule-based tutoring systems to advanced data-driven and generative models capable of producing human-like language, explanation, and instructional content. Generative AI, particularly large language models (LLMs) such as ChatGPT, represents a significant shift in educational technology by enabling real-time dialogue, adaptive feedback, and content generation across multiple academic tasks (Zhai, 2022). Unlike earlier AI systems designed for narrow instructional purposes, Generative AI operates as a general-purpose cognitive tool, capable of supporting learning, teaching, and assessment activities simultaneously. Existing literature highlights multiple affordances of Generative AI in education, including personalized learning support, enhanced academic writing, lesson planning assistance, and increased efficiency in information processing (Kofinas et al., 2025). However, scholars also caution that these technologies raise critical concerns related to academic integrity, epistemic trust, cognitive offloading, and the erosion of higher-order thinking skills if used uncritically (Kasneci et al., 2023). These concerns underscore the importance of understanding not only how AI is used, but how it is perceived and conceptualized by learners and educators.

Teachers' and Pre-Service Teachers' Perceptions of AI

Research on teachers' perceptions of AI has expanded rapidly in recent years, particularly following the public release of Generative AI tools. Studies indicate that educators generally hold mixed perceptions, characterized by optimism regarding instructional support and anxiety about professional relevance, ethical implications, and student dependency (Petrucco et al., 2025). Pre-service teachers, in particular, occupy a unique position as both learners and future professionals, making their perceptions especially influential for long-term educational change. Several studies report that pre-service teachers perceive AI as a helpful instructional aid that can support lesson planning, assessment design, and content explanation (Kohnke & Zou, 2025). At the same time, concerns about over-reliance, loss of creativity, and diminished critical thinking are frequently reported (Kasneci et al., 2023). These ambivalent perceptions suggest that pre-service teachers do not hold a single, uniform view of AI, but rather negotiate its meaning in relation to their professional identity and pedagogical values. Despite this growing body of work, much of the existing research adopts survey-based or attitude-focused approaches, which capture surface-level perceptions but provide limited insight into the deeper cognitive and experiential dimensions of AI engagement (Zawacki-Richter et al., 2019). As a result, the meaning-making processes through which pre-service teachers interpret Generative AI remain insufficiently explored.

Cognitive Representations, Mental Models, and Teacher Beliefs

Cognitive representations refer to the internal mental structures individuals use to interpret and

understand complex phenomena, including beliefs, metaphors, schemas, and mental models (Johnson-Laird, 1983; Pajares, 1992). In educational contexts, teachers' cognitive representations play a central role in shaping instructional decisions, classroom practices, and responses to innovation (Fives & Buehl, 2012). Teacher belief research consistently demonstrates that beliefs formed during pre-service training are particularly resilient and tend to persist into professional practice (Pajares, 1992). These beliefs influence how teachers interpret new technologies, whether they adopt or resist them, and how they integrate them pedagogically (Ertmer & Ottenbreit-Leftwich, 2014). When applied to Generative AI, cognitive representations may determine whether pre-service teachers view AI as a threat, a shortcut, a collaborator, or a pedagogical partner. Metaphors are especially important indicators of cognitive representation, as they reveal how individuals conceptually frame abstract technologies (Lakoff & Johnson, 1980). Studies in educational technology suggest that metaphors such as "tool," "assistant," or "partner" reflect fundamentally different orientations toward technology integration (Säljö, 2002). However, empirical research examining metaphorical representations of Generative AI among pre-service teachers remains limited.

Phenomenological Approaches to Studying AI in Education

Phenomenology focuses on understanding how individuals experience and assign meaning to phenomena in their lived worlds (Moustakas, 1994). In educational research, phenomenological approaches have been used to explore teachers' lived experiences of reform, technology adoption, and professional change (Creswell & Poth, 2018). Given the novelty and rapid diffusion of Generative AI, phenomenology offers a particularly suitable framework for examining pre-service teachers' cognitive representations. Rather than measuring predefined variables, phenomenology allows researchers to uncover how participants describe, interpret, and emotionally relate to AI through their own language, metaphors, and narratives. This approach is especially relevant in under-researched contexts such as public sector teacher education colleges in Pakistan, where socio-cultural and institutional factors shape technology experiences in distinctive ways.

Although existing literature provides valuable insights into the applications and perceived benefits of AI in education, there remains a notable gap in research examining how pre-service teachers cognitively represent Generative AI through lived experience, particularly within public sector institutions in developing contexts. Few studies adopt a phenomenological lens to explore the meaning structures, metaphors, and identity negotiations associated with AI use in teacher education. Addressing this gap is essential for developing teacher preparation programs that move beyond technical training toward reflective, ethical, and pedagogically sound engagement with Generative AI.

Research Methodology

Research Design

This study adopted a qualitative phenomenological research design to explore the cognitive representations of Generative Artificial Intelligence (GAI) among pre-service teachers. Phenomenology is concerned with understanding how individuals experience a phenomenon and how meaning is constructed through those experiences (Moustakas, 1994; Ahmed et al., 2024). Given that the purpose of the study was to capture pre-service teachers' lived experiences, beliefs, metaphors, and meaning-making processes regarding Generative AI, a phenomenological approach was deemed most appropriate.

Participants and Sampling

The study was conducted at a public sector teacher education college in Karachi, Pakistan.

Participants consisted of pre-service teachers enrolled in Bachelor of Education (B.Ed.) program. A purposive sampling strategy was employed to select participants who had prior experience using Generative AI tools, particularly ChatGPT, for academic or educational purposes. Purposive sampling is recommended in phenomenological studies to ensure that participants have directly experienced the phenomenon under investigation (Patton, 2015).

As shown in Table 1, 26 pre-service teachers participated in the study. This sample size aligns with phenomenological research guidelines, which emphasize depth of data over breadth and typically involve smaller, information-rich samples (Creswell & Poth, 2018; Moustakas, 1994). All participants were female. The mean age of participants was 22.08 years (SD = 4.01). All participants (100%) reported using at least one Generative AI tool, indicating universal exposure to AI technologies within the sample. Among specific tools, ChatGPT emerged as the most frequently used platform (92.3%), followed by Gemini (57.7%) and Meta AI (34.6%). This distribution suggests a strong preference for text-based large language models, particularly ChatGPT, among pre-service teachers.

Table 1. Demographics of Participants

Gender	Mean Age (SD)	AI Use (Any Tool)	ChatGPT Users	Gemini Users	Meta AI Users
Female (n = 26)	22.08 (±4.01)	26 (100%)	24 (92.3%)	15 (57.7%)	9 (34.6%)

Data Collection & Analysis

Data were collected through semi-structured, in-depth interviews, which are widely used in phenomenological research to elicit rich descriptions of lived experiences (Moustakas, 1994). An interview protocol was developed to guide the conversations while allowing flexibility for participants to elaborate on their experiences and reflections. Data were analyzed using thematic analysis within a phenomenological framework, following the principles outlined by Braun and Clarke (2006). This analytic approach allowed the researchers to remain grounded in participants' voices while systematically identifying shared cognitive representations.

Ethical Considerations

Ethical approval was obtained from the relevant institutional authority prior to data collection. Participants were informed about the purpose of the study, the voluntary nature of participation, and their right to withdraw at any stage without penalty. Informed consent was obtained, and confidentiality was maintained by anonymizing participant identities using codes (e.g., P1, P2). Audio recordings and transcripts were securely stored and used solely for research purposes.

Findings

This study explored the cognitive representations of Generative Artificial Intelligence (GAI) among pre-service teachers enrolled in a public sector teacher education college in Karachi. Through phenomenological analysis of semi-structured interviews, participants' lived experiences, metaphors, and reflections revealed how they perceive, interpret, and negotiate the presence of Generative AI in their academic and professional lives. The findings are organized into six themes, as shown in Figure 1, which collectively illuminate the central phenomenon: pre-service teachers' meaning-making of Generative AI as both an empowering and destabilizing educational force.

Theme 1: Generative AI as a Helping Hand

A dominant cognitive representation across participants was that of Generative AI as a supportive

assistant or helping hand. Pre-service teachers frequently described AI as a readily available source of guidance that assists them when human support is limited or unavailable. This support was particularly valued for assignments, conceptual clarification, and academic writing. One participant explained, "When we're working on something but don't know where to start, then we can take some information from ChatGPT, but we should also add our own input." (P1) Similarly, another participant shared, "Whenever I don't understand something, I can ask AI questions. It helps me instantly, like a helping hand." (P5) For many participants, AI functioned as a form of cognitive scaffolding that reduced academic anxiety and increased confidence. However, this assistance was often framed conditionally, with participants emphasizing the need to retain personal effort and thinking.

Theme 2: Metaphorical Humanisation of Generative AI

Participants consistently relied on human and relational metaphors to describe Generative AI, reflecting an anthropomorphic cognitive framing. AI was frequently described as a teacher, friend, mentor, guide, or companion, suggesting emotional and social dimensions in how participants relate to the technology. One participant stated, "If I use a simple word, I would call AI a friend — a special friend, because it feels personalized." (P3) Another participant remarked, "For me, AI is like a digital teacher. At home, if I don't understand something, I ask AI instead." (P7) These metaphors indicate that participants did not merely perceive AI as a mechanical tool but as a socially present entity capable of interaction, responsiveness, and personalization. Such representations reflect the evolving nature of human–technology relationships in educational contexts.

Theme 3: Perceived Intelligence of AI

While participants acknowledged the advanced capabilities of Generative AI, they commonly emphasized that its intelligence is artificial and fundamentally derived from human knowledge. This distinction allowed participants to appreciate AI's functionality while maintaining a sense of human intellectual superiority. One participant explained, "This intelligence actually comes from human intelligence because machines learn from data given by humans." (P3) Another noted, "AI is intelligent, but humans are more intelligent. Everything in AI comes from humans." (P4) This theme reflects a nuanced cognitive understanding in which AI is perceived as powerful yet epistemologically dependent on human input. Participants often used this reasoning to justify why AI should assist rather than replace teachers.

Theme 4: Dependence Anxiety and Fear

Alongside appreciation, participants expressed deep concern about overdependence on Generative AI. Many feared that excessive reliance could weaken creativity, critical thinking, and independent problem-solving skills. One participant cautioned, "If we depend completely on AI, our ability to think will disappear." (P9) Another participant openly reflected, "I feel afraid to use AI too much, because I might stop thinking on my own." (P4) Several participants described personal experiences of becoming "lazy" or overly reliant on AI for assignments, which led to internal conflict and guilt. This anxiety highlights a central tension in participants' lived experiences: AI as both a facilitator and a threat to intellectual autonomy.

Theme 5: Reconstruction of Teacher Identity in the Age of AI

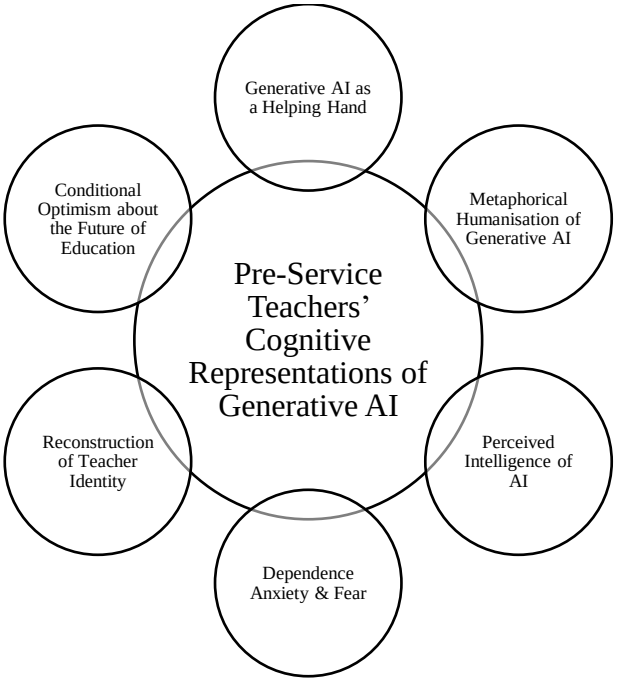
Participants consistently described a shift in how they perceive their future professional roles. Rather than viewing themselves as sole knowledge providers, pre-service teachers increasingly positioned themselves as facilitators, mentors, and guides who work alongside AI. One participant articulated this shift clearly: "Teachers will not be the only source of knowledge anymore. Our role

will be to guide students and help them use AI properly." (P16) Another explained, "AI cannot replace teachers. Teachers will start the process, and AI will help alongside." (P3) This reconstruction of teacher identity reflects an adaptive response to technological change, emphasizing pedagogical judgment, ethical guidance, and human connection as core professional values.

Theme 6: Conditional Optimism about the Future of Education

Participants expressed mixed but reflective views about the future of education with Generative AI. While many described the future as "bright," this optimism was consistently conditional on ethical use, moderation, and continued human involvement. One participant stated, "The future is bright if we use AI wisely." (P11) In contrast, others expressed concern: "If students stop using their own minds, then the future is dark." (P17) Several participants used balanced metaphors, such as: "AI is like a candle — it gives light, but it can also burn." (P22) This theme encapsulates the core phenomenological finding of the study: Generative AI is experienced as a double-edged phenomenon, offering significant educational promise while simultaneously posing risks to cognition, creativity, and human connection.

Figure 1. Thematic Map



Discussion

The present phenomenological case study sought to explore the cognitive representations of Generative Artificial Intelligence among pre-service teachers enrolled in a public sector teacher education college in Karachi. The findings reveal that participants' lived experiences with Generative AI are characterized by ambivalence**,** humanisation**,** and identity negotiation, rather than uncritical acceptance or outright rejection. These findings align with and extend existing research on educators' perceptions of AI by foregrounding the meaning-making processes underlying technology adoption.

One of the most salient findings was the recurrent representation of Generative AI as a "helping hand," "guide," "teacher," or "friend." This humanisation of AI reflects a shift from viewing educational technologies as passive tools toward perceiving them as interactive cognitive partners.

Similar representations have been reported in recent studies where pre-service teachers described AI as supportive, responsive, and pedagogically useful (Kofinas et al., 2025). From a cognitive perspective, such metaphors indicate that Generative AI is being integrated into learners' existing social and instructional schemas, which is consistent with sociocultural theories of learning that emphasize mediation and scaffolding (Vygotsky, 1978). However, this human-like framing also raises concerns. Prior research cautions that anthropomorphizing AI may obscure its limitations and reinforce overtrust, particularly among novice educators (Holmes et al., 2019). The findings of the present study echo this tension, as participants simultaneously acknowledged AI's usefulness and expressed apprehension about excessive reliance.

A significant theme emerging from the findings was dependence anxiety, marked by fears of reduced creativity, diminished critical thinking, and erosion of effort. Participants frequently articulated a struggle between convenience and cognitive autonomy. This aligns with earlier work suggesting that while AI can enhance efficiency, it may also encourage surface-level engagement if not pedagogically guided (Zawacki-Richter et al., 2019).

From a phenomenological standpoint, this tension reflects cognitive dissonance—participants value independent thinking but simultaneously rely on AI for academic survival in resource-constrained contexts. In the public sector college setting of Karachi, where large class sizes and limited academic support are common, Generative AI appears to function as an informal compensatory mechanism. This contextual dimension is underrepresented in Global West-dominated AI literature and underscores the importance of situating AI research within local educational realities.

Another key finding was the perceived reconstruction of teacher identity, with participants envisioning a shift from traditional knowledge transmission toward facilitation, mentoring, and guidance. Similar trends have been observed in international studies, where teachers increasingly view AI as a pedagogical assistant rather than a replacement (Kohnke & Zou, 2025). Importantly, participants in this study largely rejected the idea that AI could replace teachers, emphasizing the irreplaceable human elements of teaching—empathy, moral guidance, and contextual understanding. This aligns with research highlighting that teacher beliefs play a decisive role in shaping technology integration practices (Pajares, 1992; Fives & Buehl, 2012). The findings suggest that pre-service teachers' cognitive representations of AI will likely influence whether AI is used as a reflective aid or as a shortcut in future classrooms.

Participants' views of the future of education were best described as conditionally optimistic. While many anticipated improvements in access, efficiency, and instructional support, these expectations were consistently tempered by ethical concerns and warnings against unregulated use. This balanced stance mirrors global discourse on AI in education, which increasingly emphasizes responsible, human-centred integration rather than technological determinism (Holmes & Miao, 2023).

Conclusion

This phenomenological case study provides nuanced insights into how pre-service teachers in a public sector teacher education college in Karachi cognitively represent Generative AI. The findings demonstrate that Generative AI is not merely perceived as a technological innovation, but as a meaning-laden phenomenon that reshapes beliefs about learning, teaching, and professional identity. Participants' representations were characterized by humanisation, perceived cognitive support, dependence anxiety, and a reimagining of the teacher's role in AI-mediated educational environments.

The study contributes to the growing body of literature on AI in education by foregrounding lived experience and meaning-making, an area often overlooked in survey-based research. By focusing on a Global South context, it also addresses an important geographic and contextual gap in existing scholarship.

Recommendations

Based on the findings of this phenomenological case study, it is recommended that teacher education programs in public sector institutions systematically integrate AI literacy and reflective engagement into pre-service teacher preparation. Rather than focusing solely on technical skills, programs should emphasize developing critical, ethical, and pedagogical understandings of Generative AI, enabling pre-service teachers to conceptualize AI as a supportive cognitive tool rather than a replacement for human thinking or teaching. Additionally, professional development initiatives for teacher educators are essential to ensure consistent, informed, and ethical modelling of AI use. At the policy level, clear institutional guidelines should be developed to promote balanced and responsible AI integration, safeguarding academic integrity while encouraging innovation. Finally, assessment practices should be redesigned to prioritize higher-order thinking, creativity, and reflective reasoning, thereby mitigating over-dependence on AI and reinforcing the irreplaceable role of human judgment and pedagogical expertise in education.

Directions for Future Research

As a phenomenological case study situated in a single public sector institution, the findings are not intended for statistical generalization. Future research may extend this work through comparative studies across public and private institutions, longitudinal designs examining belief evolution over time, or mixed-method approaches integrating cognitive representations with classroom practices.

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