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Generative Artificial Intelligence (GenAI) engagement in academic writing among foundation science students in the pre-pharmacy programme

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ABSTRACT

As the use of Generative Artificial Intelligence (GenAI) in higher education has changed academic literacy practices, little is known about its application to pre-pharmacy education. Students must acquire scientific communication, accurate paraphrasing, and literature synthesis abilities during the crucial preparation phases of foundation science programmes. The experiences, learning procedures, and ethical issues that foundation science students experienced when utilising GenAI tools for academic writing development at a public university in Malaysia were investigated in this case study. Pre-pharmacy foundation students (n = 12) participated in semi-structured focus groups to gather data, supplemented by examination of curriculum materials, evaluation criteria, and writing portfolios. To ensure interpretive depth, an iterative manual thematic analysis method was used. Five themes surfaced: (1) GenAI as a linguistic support tool for improving vocabulary and paraphrasing; (2) conflict between cognitive scaffolding and reliance on AI-generated structures; (3) difficulties in synthesising complex academic literature; (4) ethical concerns about plagiarism and anxiety about AI detection; and (5) perceptions of preparedness for advanced scientific communication in pharmacy education. While GenAI is known for assisting ESL students with early academic writing and lowering cognitive hurdles, excessive reliance can lead to mechanical dependence, diminishing the capacity for independent synthesis, rhetorical control, and analytical depth. Consequently, a unique and concerning phenomenon emerges from this empirical dataset, which this study defines as 'The Illusion of Learning'. The study offers empirical insights for creating organised GenAI-integrated writing frameworks in pre-pharmacy programmes to improve students' preparedness for clinical decision-making and evidence-based scientific communication.

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1. INTRODUCTION

The rapid spread and normalisation of Generative Artificial Intelligence (GenAI) technologies in recent years have fundamentally altered how students approach text production, creativity, and linguistic translation across higher education (Li et al., 2023). This technological shift introduces unique challenges to extreme academic rigour, such as pharmacy. As clinical precision directly affects patient safety, undergraduate pharmacy students must independently synthesise complex clinical literature, produce systematic evidence reviews, and prepare intricate laboratory reports (Katzung & Vanderah, 2021). To understand how future practitioners will navigate this GenAI-influenced landscape, attention must turn to the pre-university programme. Empirical admission trends within the target public university centre directly support focusing on this particular sub-cohort; a significant 60.71% (n = 17) of the baseline cohort of 28 registered pre-university science students surveyed in this study expressed a strong professional interest in enrolling in a Bachelor of Pharmacy degree programme. This high level of interest necessitates a study on students' academic readiness in digital and textual literacy before enrolling in undergraduate studies.

This statistical trend underscores that academic writing proficiency at this preparatory stage remains an essential prerequisite for future success (Taye & Teshome, 2025). During this short preparatory period, these prospective pharmacy students are expected to quickly transition away from the descriptive, teacher-led writing styles typical of secondary schooling toward highly analytical, evidence-based arguments, structural synthesis, and specialised medical terminology (Pitts et al., 2022). To bridge this steep academic divide, students increasingly turn to Generative AI. These digital tools offer highly personalised, instantaneous linguistic scaffolding that helps learners correct localised syntax problems, improve writing flow, and overcome the daunting cognitive obstacle**.** Furthermore, GenAI tools serve as an instantaneous linguistic equaliser for students working within an English as a Second Language (ESL) paradigm, effectively converting complex personal ideas into formally structured, passive-voice scientific writing.

While a substantial body of applied linguistics research has investigated the general utility of large language models in automated essay evaluation, general second-language (L2) text generation, and secondary school composition, a distinct empirical gap persists regarding how pre-pharmacy foundation science students navigate GenAI utilities specifically for building preliminary scientific literacy (Mughal et al., 2026). The majority of current literature treats AI use in education as a uniform phenomenon, often overlooking the particular high-stakes communication needs that govern the healthcare programme (Noorbehbani & Oyibo, 2026). In professional pharmacy education, minor textual errors can have catastrophic consequences; misinterpreting clinical trial results, misrepresenting drug interaction mechanisms, or oversimplifying complex data can result in fatal medical errors (Katzung & Vanderah, 2021; Hughes, 2026). Consequently, the foundational habits formed at this pre-university stage directly condition the ethical and professional posture of the future healthcare workforce.

The abrupt institutional void surrounding GenAI initiatives in higher education further emphasises the necessity of this study. Educational institutions have often responded to the rapid spread of these tools with inconsistent policies, ranging from unrestricted use to impractical total bans (Michel-Villarreal et al., 2023). Due to this policy ambiguity, students are left to navigate complex ethical boundaries on their own, finding it extremely difficult to discern between academic dishonesty, structural plagiarism, and legitimate digital editing (Johnston et al., 2024). In this context, ESL students must master technical scientific prose in a language other than their native tongue, making them uniquely reliant on digital linguistic aids. To address this intersection of policy ambiguity and academic vulnerability, this study aims to chart the precise

functional applications of these tools and evaluate how such foundational habits influence long-term student readiness for advanced pharmaceutical education. Thus, creating an empirical baseline of these student behaviours is a crucial first step towards ensuring professional proficiency in medical communication.

2. LITERATURE REVIEW

In understanding how foundation science students interact with AI, prior research must be synthesised to pinpoint historical trends, theoretical stances, and empirical gaps that shape the current paradigm of instruction. Crucially, a study by Hyland (2016) has shown that students, particularly ESL learners, often possess a limited technical vocabulary, weak grammatical control, and little exposure to specialised academic discourse, making it extremely difficult for them to develop paraphrasing skills. These major challenges frequently result in an over-reliance on direct copying and insufficient integration of secondary sources in academic papers, which subsequently impairs writing quality, disrupts narrative coherence, and undermines the development of empirical arguments (Nurkamto et al., 2024). These persistent challenges highlight the need to investigate cutting-edge methods in overcoming language barriers and writing anxieties.

These divergent viewpoints are directly related to complex normative concerns about authorship, original intellectual property, and academic integrity in AI-assisted writing. According to research by Schei et al. (2024), pre-university students typically lack a clear, practical understanding of what constitutes permissible use of AI tools in academic settings. Furthermore, they often exhibit significant misunderstanding regarding whether AI-mediated text must be formally attributed or acknowledged (Ganjavi et al., 2024). Consequently, the absence of explicit institutional oversight may lead students to unintentionally engage in malpractice that compromises their learning outcomes, such as submitting wholly machine-generated material as original work.

Despite the increasing adoption of these tools, clear gaps persist within the current body of research. First, there is a profound shortage of empirical data analysing pre-university foundation GenAI usage patterns in academic writing tasks, as most studies predominantly focus on advanced undergraduate or postgraduate cohorts (Gabay et al., 2026). This oversight creates a significant gap in the understanding of the early, formative phases of academic literacy. Second, insufficient research examines students' internal conflicts, cognitive confusion, and structural overdependence, particularly regarding how they actively weigh the affordances and constraints of GenAI during high-stakes paraphrasing and scientific reporting assignments (Gəruslu et al., 2026). Third, current literature often ignores how normative ethics influence technology adoption, treating ethical awareness as a peripheral issue rather than a fundamental component of AI-assisted writing habits (Ghosh, 2025). Consequently, addressing these tripartite empirical gaps is essential to map the reality of early academic literacy and safeguard institutional integrity within the modern higher education programme.

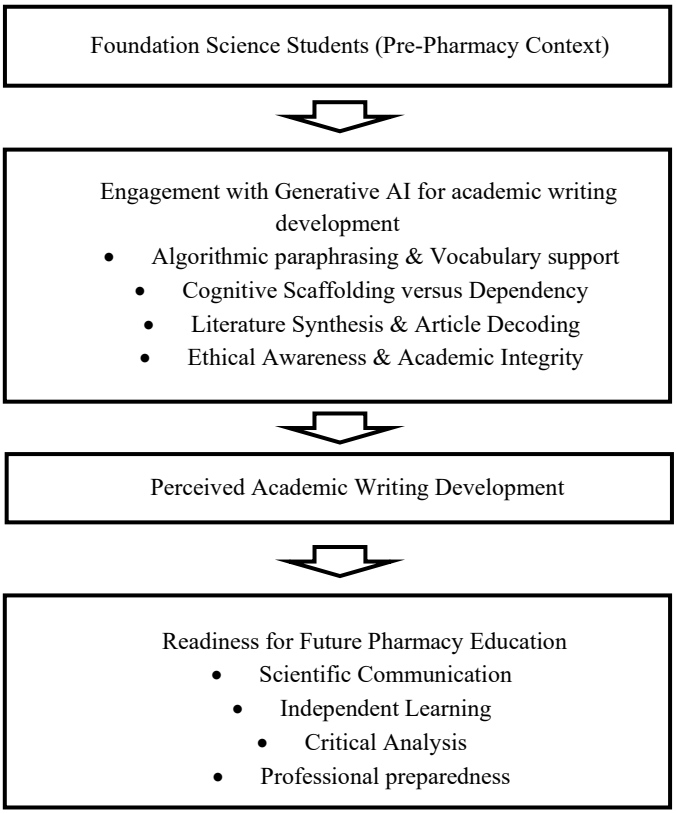

Fig. 1. Conceptual framework

As illustrated in Fig. 1, the conceptual framework posits that students' perceptions of the usefulness and technical difficulties of GenAI tools actively control the degree and quality of their involvement, directly impacting their paraphrasing and overall academic writing performance. At the same time, ethical awareness helps determine whether students use GenAI as a permanent substitute for their own thinking or responsibly as a temporary learning support. (Ngo & Hastie, 2025). This structural interaction reflects a broader, ongoing controversy within current educational research surrounding the intersection of technological innovation and traditional academic values (Gəruslu et al., 2026). While GenAI has demonstrated considerable potential to enhance students' writing quality and fluency, supporting its use as an effective learning aid in language education (Rahmi et al., 2024), it is warned that excessive reliance on these tools may impede the development of independent writing skills, critical thinking, and a distinctive authorial voice (Aljuaid, 2025). This tension between cognitive support and learner dependency remains a central issue in contemporary research on AI-assisted academic writing. This review, therefore, establishes the essential theoretical foundation for the subsequent methodology section, demonstrating how the present study directly addresses these unresolved tensions at the gateway of professional health sciences training.

3. METHODOLOGY

To capture the rich, context-dependent operational realities of foundation science students engaging with generative AI utilities, this investigation adopted a qualitative single-case study design. This approach strictly followed the epistemological and methodological principles articulated by Yin (2018), which emphasise the detailed exploration of a contemporary phenomenon within its real-world educational setting, particularly when the boundaries between the phenomenon and the context are not sharply defined. The overarching institutional 'case' was bounded within a single premier foundation science centre situated at a major public university in Malaysia. This site was strategically selected due to its institutional status as a primary nationwide feeder programme for highly competitive professional undergraduate programmes, specifically the Faculty of Pharmacy, as evidenced by the reality that 60.71% (n = 17) of the surveyed baseline cohort intend to pursue pharmacy tracks. The boundedness of the case ensured that all participants operated under uniform curriculum requirements, shared modular deadlines, and consistent baseline expectations regarding science-based academic writing benchmarks, thereby providing an ideal environment for localised, deep-dive qualitative inquiry.

A purposive sampling strategy was rigorously executed to select information-rich participants from the pre-pharmacy and life sciences foundation tracks (Osman et al., 2022). Aligning with the case study selection principles outlined by Yin (2018), participants were required to meet three strict inclusion criteria: (1) current enrolment as full-time foundation science students within the selected public university centre; (2) active engagement with science-based academic writing components, research portfolios, or laboratory report assessments during the current academic semester; and (3) self-reported operational experience with one or more GenAI utilities, such as ChatGPT, Claude, or specialised automated paraphrasing engines, for academic text production.

Through collaboration with course coordinators, a final sample size of twelve foundation students (n = 12) was established. In qualitative inquiry, sample size determination is guided by data saturation rather than statistical power calculations; within small-cohort case study designs, a sample of 10 to 12 participants across small focus groups is well-established as sufficient to achieve thematic code saturation (Guest et al., 2020; Hennink & Kaiser, 2022). This cohort was purposefully distributed across three distinct semi-structured focus group discussions (FGDs), with each session comprising four participants and lasting between 60 and 75 minutes. To acknowledge their time and contribution without compromising voluntary participation, participants received a token of appreciation (a modest monetary voucher and light refreshments) upon session completion. All discussions were audio-recorded with the explicit, written informed consent of the participants and subsequently transcribed verbatim to ensure absolute interpretive accuracy. To achieve rigorous structural triangulation, the primary FGD data were supplemented by a comprehensive document analysis of institutional academic writing portfolios, official assessment rubrics, laboratory reporting templates, and formal course syllabi (Khan et al., 2019). This dual-method approach allowed the researcher to systematically evaluate the objective curriculum requirements imposed on the cohort against their lived operational experiences (Yin, 2018).

Rather than relying on computerised qualitative data analysis software, the transcripts and secondary document collections in this study underwent a rigorous, manual thematic analysis. This deliberate methodological choice aligns with the core qualitative paradigm described by Braun and Clarke (2006), which emphasises that the researcher's cognitive immersion serves as the primary analytical instrument for identifying subtle, latent meanings within the text. To mitigate researcher bias inherent in single-analyst

qualitative coding, the initial thematic framework derived by the primary researcher underwent an independent peer-examination and audit process. An experienced qualitative colleague independently reviewed the raw transcripts and proposed codebook; subsequent collaborative debriefing sessions were conducted to compare interpretations, resolve discrepancies, and reach a consensus on the final five emergent themes, thereby bolstering inter-coder agreement and analytical trustworthiness (Lincoln & Guba, 1985).

To ensure methodological rigour and transparency, the operational execution of this qualitative case study followed a systematic, multi-stage structure. Table 1 summarises the overall research design, encompassing the setting, participant demographics, data collection streams, and trustworthiness measures.

Table 1. Research design summary

Methodological Element	Description
Research Design	Qualitative Single Case Study
Research Purpose	To explore foundation science students' experiences, perceptions, and ethical considerations regarding the use of Generative AI in academic writing
Research Setting	Premier Foundation Science Centre, Public University, Malaysia
Participants	(n = 12) Foundation Science students
Sampling Strategy	Purposive sampling
Data Collection	Three semi-structured focus group discussions
Secondary Data	Writing portfolios, assessment rubrics, laboratory report templates, and course syllabi
Data Analysis	Manual six-phase thematic analysis
Trustworthiness	Member checking, document triangulation, thick description
Case Boundaries	One Foundation Science Centre in Malaysia

Complementing this framework, Fig. 2 illustrates the sequential research process flow, from initial participant selection through data collection to final thematic synthesis.

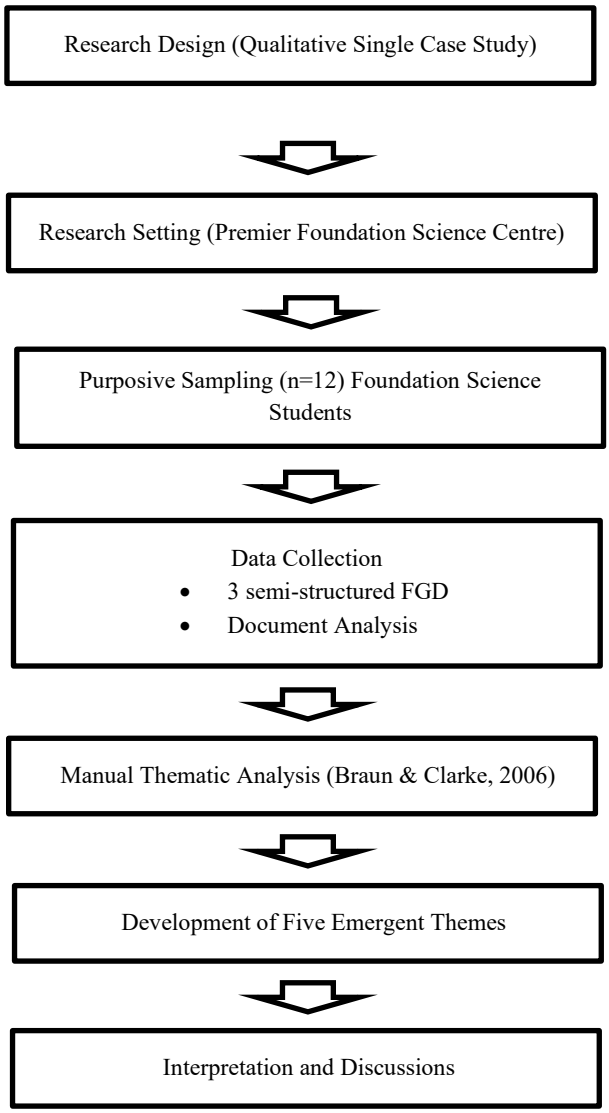

Fig. 2. Research process flow

While Fig. 2 maps the macro-level operational stages of the study, the micro-level analytical strategy applied to the qualitative dataset required a dedicated, structured protocol, Fig. 3 delineates this analytical execution step-by-step, following the six-phase framework established by Braun and Clarke (2006). This process guided the data transformation from raw textual transcripts into preliminary codes, clustered sub-themes, and ultimately, the finalised five emergent themes.

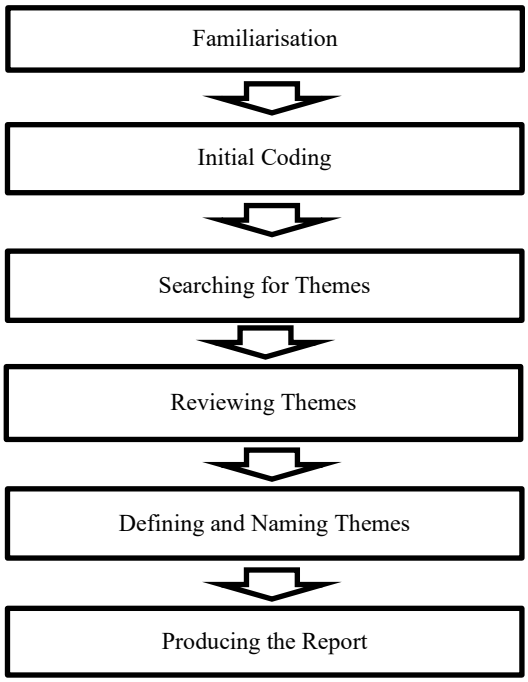

Fig. 3. Six-phase manual thematic analysis process

Source: Braun & Clarke (2006)

4. FINDINGS

Through the manual thematic analysis, five main themes emerged regarding students' experiences with GenAI in academic writing. Table 2 summarises these themes, their core focus, coding frequencies, and relative prevalence within the complete qualitative dataset, serving as a roadmap for the detailed discussion presented in Sections 4.1–4.5. Complementing the table, Fig. 4 displays a horizontal bar chart of the coding frequencies, offering an immediate visual comparison of their relative weight across the qualitative dataset.

Table 2. Distribution of emergent themes

Theme	Core Focus	Coding Frequency (n)	Percentage (%)
Algorithmic Paraphrasing and Vocabulary Synthesis	Linguistic filtering, vocabulary enhancement, and stylistic refinement	42	29.2
Scaffolding versus Structural Dependency	Cognitive support versus over-reliance on AI	34	23.6
Literature Synthesis and Article Decoding	Simplification and interpretation of scientific literature	29	20.1
Systemic Ethical Ambiguity	Ethical uncertainty and plagiarism concerns	23	16.0
Pharmacy Program Readiness	Readiness for future academic and professional demands	16	11.1
Total		**144**	**100.0**

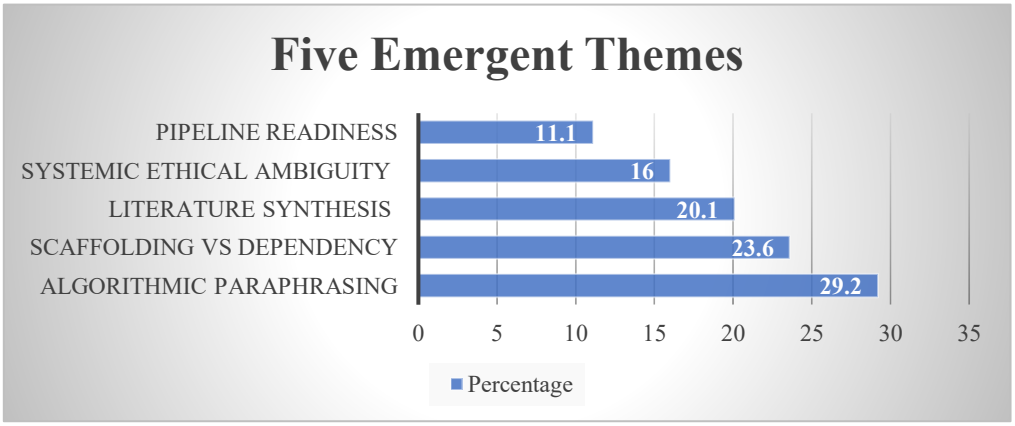

Fig. 4. Five emergent themes

4.1 Algorithmic paraphrasing and vocabulary synthesis

The largest proportion of participant discourse focused on using GenAI platforms as real-time mechanisms for language filtering and lexical collocation (n = 42, 29.2%). Conceptual comprehension was rarely the main barrier for foundation science students working in an English as a Second Language (ESL) environment; instead, the ongoing difficulty was carrying out the formal academic register and passive-voice structures required by scientific reporting. Participants admitted relying on AI as a stylistic engine, with one student explaining:

"I know the science in my head, but I don't know how to write it like a real scientist. My English isn't strong enough to sound professional, so I rely on AI to fix my words." (FGD1, Participant 3)

By feeding rough drafts into GenAI to 'make this sound professional', students received polished outputs. However, this immediate ease introduced pedagogical risks by removing students from the productive linguistic struggle. Crucially, while writing portfolios initially corroborated surface-level proficiency, oral focus group cross-examinations revealed several students could not define the sophisticated terms their AI tools inserted. As one participant conceded:

"When the lecturer asked me to explain what 'ameliorate' meant in my report, I couldn't really explain because ChatGPT put that word there, not me." (FGD2, Participant 1)

This finding reveals a significant discrepancy between surface text quality and internalised student capability, illustrating how automated text augmentation hides underlying comprehension difficulties. (Mahapatra, 2024; Rahmi et al., 2024). Specifically, while GenAI platforms polish grammar and syntax to mask underlying conceptual gaps, students remain unable to articulate or defend the complex scientific arguments presented in their own submitted work.

4.2 Scaffolding versus structural dependency

A profound dualism emerged regarding the cognitive and structural consequences of AI integration (n = 34, 23.6%). Initially, GenAI functioned as constructive pedagogical scaffolding to alleviate writing anxiety by providing essay blueprints, thesis options, and logical transitions. One participant highlighted this supportive function:

"When I face a blank page, I panic. Using AI to generate an outline gives me a starting framework, and then I fill in the actual scientific content myself." (FGD3, Participant 2)

Conversely, when facing overlapping modular deadlines, this operational ease frequently deteriorated into counterproductive structural dependency. Focus groups revealed that rather than engaging in the cognitive friction of synthesising arguments, students turned to iterative prompting to assemble entire paragraphs. As another student candidly admitted:

"When deadline week hits, I don't have time to construct every sentence. I just feed my raw bullet points into Claude and ask it to write the whole paragraph for me." (FGD1, Participant 4)

Ultimately, this reliance fosters 'artificial competence', which leaves students with a cursory understanding of academic writing structure (Zhai et al., 2024). Learners successfully avoid the cognitive strain needed to internalise fundamental scientific concepts and autonomous analytical thinking by depending on outside algorithms to arrange and synthesise their prose.

4.3 Literature synthesis and article decoding

When encountering peer-reviewed scientific literature for the first time, students reported severe cognitive overload caused by complex experimental designs and specialised biochemical terminology (n = 29, 20.1%). To cope, participants regularly fed journal abstracts or methodology chapters directly into GenAI interfaces for rapid summaries. One participant noted:

"Reading full research papers takes hours because of the dense jargon. AI condenses a 10-page journal article into three simple bullet points in five seconds." (FGD2, Participant 4)

While providing a surface-level grasp, this 'article decoding' systematically insulated students from critical reading skills (Kim et al., 2024). Analysis of writing portfolios revealed generic summaries lacking methodological critique, primarily because students relied on flattened AI summaries rather than full texts. A participant acknowledged this limitation:

"I cited five papers in my literature review, but if you ask me about their experimental controls, I wouldn't know because I only read the AI's simplified summary." (FGD3, Participant 1)

This habit undermines the foundational objective of developing analytical minds capable of appraising empirical evidence.

4.4 Systemic ethical ambiguity

A pervasive undercurrent of ethical ambiguity and operational anxiety was evident across all cohorts (n = 23, 16.0%). Without explicit institutional policies, students struggled to navigate the boundary between legitimate grammar editing and unauthorised content generation. This stress was compounded by institutional AI detection software, which flagged original text as AI-generated. One student expressed this frustration:

"I wrote my report completely on my own, but after using Grammarly to check tenses, the Turnitin AI detector flagged it as 40% AI. It made me feel like an didn't do the work at all." (FGD1, Participant 2)

This anxiety triggered a counterproductive adaptation where students deliberately degraded their finalised text to lower detection scores. *This striking behavioural adaptation, effectively a form of 'reverse editing', vividly demonstrates the unintended counter-pedagogical impacts of aggressive AI surveillance and policy ambiguity.* As one student revealed:

"Before submitting, I intentionally add grammatical flaws or change smooth sentences back into awkward ones just to lower the AI detection score." (FGD2, Participant 3)

Driven by systemic paranoia, students feel forced to sabotage their own developing scientific literacy, prioritising algorithmic compliance over academic excellence (Ngo & Hastie, 2025). This defensive behaviour is particularly pronounced among English as a Second Language (ESL) learners, who intentionally downgrade their legitimate, highly polished prose to lower AI-detector probability scores and avoid false accusations of misconduct.

4.5 Pharmacy program readiness perception

The final theme revealed that students' critical awareness of AI-mediated behaviours impacts their perceptions of downstream professional preparedness (n = 16, 11.1%). Notably, a distinct segment recognised that over-reliance on automated tools creates a fragile illusion of competence, a critical concern given that 60.71% (n = 17) intend to pursue undergraduate pharmacy degrees. One participant reflected:

"In pharmacy, a mistake in drug evaluation could harm a patient. If I rely on AI to think for me now, I won't have the critical appraisal skills needed for clinical decision-making later." (FGD3, Participant 3)

Nevertheless, students described feeling trapped in a short-term survival loop where high GPA demands force them to maintain algorithmic dependencies. As another student summarised:

"We know deep down that over-using AI hurts our long-term learning, but right now, surviving the foundation semester with a top CGPA is more important." (FGD1, Participant 1)

This tension underscores an urgent need for structural pedagogical interventions that realign short-term academic metrics with long-term professional healthcare standards (Pitts et al., 2022). Without such reforms, educational institutions risk graduating algorithmically dependent students into clinical environments where unverified data interpretation and superficial analytical skills directly compromise evidence-based practice and patient safety.

5. DISCUSSION

This study reveals a key educational gap in pre-health sciences training, showing that generative AI quickly improves students' language and writing, but can simultaneously hinder their deep learning and critical thinking. To fully comprehend the systemic implications of these findings, the student-AI interaction must be analysed through the lens of established educational and behavioural frameworks. Structurally, the observed behavioural patterns correspond directly with Vygotsky's Zone of Proximal Development and the associated Scaffolding Theory (Vygotsky, 1978; Wood et al., 1976), which posits that external tools can provide temporary support to help learners accomplish tasks beyond their independent developmental capacity. In an ideal educational scenario, this digital scaffolding will gradually fade as the student internalises linguistic mechanics, rhetorical structures, and argumentative logic, ultimately culminating in autonomous competence.

However, the qualitative data reveals that within this unguided student ecology, the essential fading process is absent. These findings corroborate previous research suggesting that while GenAI can function as an effective learning scaffold, excessive reliance risks eroding independent writing abilities and higher-order cognitive engagement (Kim et al., 2024; Mahapatra, 2024; Zhai et al., 2024). The technology has developed into a permanent, inflexible algorithmic reliance that deliberately prevents the internalisation of critical literacy abilities, rather than serving as a temporary bridge.

This rapid, unregulated adoption can be further conceptualised through the Technology Acceptance Model (TAM), which posits that an individual's intention to adopt a new system is primarily determined by two core constructs: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Rahmi et al., 2024; Wang, 2024). The qualitative focus group data demonstrate that both constructs operate at maximum capacity for foundation science students interacting with GenAI platforms. However, applying TAM uncritically within an educational setting exposes a dangerous paradox: in the context of academic writing development, 'perceived ease of use' frequently operates in direct opposition to deep cognitive processing. Authentic learning inherently requires cognitive friction, the challenging, uncomfortable intellectual labour of organising disjointed thoughts, evaluating contradictory evidence, and manually constructing a synthesised narrative. By eliminating this essential friction, the technology facilitates rapid task completion while bypassing the cognitive pathways responsible for structural depth and long-term skill retention (Zhai et al., 2024). Consequently, the seamless execution of text generation ultimately compromises the foundational cognitive development necessary for autonomous scholarship.

Consequently, a unique and concerning phenomenon emerges from this empirical dataset, which this study defines as the 'Illusion of Learning'. While previous research has reported the efficiency of GenAI in supporting basic writing tasks (Rahmi et al., 2024; Wang, 2024), the present findings extend this literature by demonstrating how students equate high-quality, AI-generated outputs with genuine academic mastery. This phenomenon characterises an operational state in which students believe they are actively developing their analytical capabilities simply because their final written products are of a high calibre. As the AI-mediated output appears professional, objective, and grammatically flawless, students experience a false sense of intellectual mastery, conflating the machine's algorithmic competence with their own internalised literacy. This illusion creates a fragile academic persona that is highly vulnerable to collapse when students are placed in controlled, unassisted environments, such as synchronous examinations, viva voces, or real-time clinical case analyses. Within the professional pharmacy education programme, this vulnerability is critical. Professional practice requires rigorous adverse drug reaction reporting, meticulous

evaluation of clinical trial literature, and absolute accuracy in data interpretation (Katzung & Vanderah, 2021). If students transition into these high-stakes modules with an algorithmically dependent capability, their inability to independently process complex pharmacokinetics or clinical literature could ultimately compromise patient safety and undermine evidence-based practice.

The integration of the five emergent themes indicates a progressive shift in learners' cognitive engagement when interacting with generative AI tools in academic writing contexts. This paper synthesises these patterns into a conceptual continuum that demonstrates how, under conditions of excessive algorithmic dependency, true learning may progressively give way to an illusion of learning. Fig. 5 presents this continuum as an emergent model derived from the qualitative dataset.

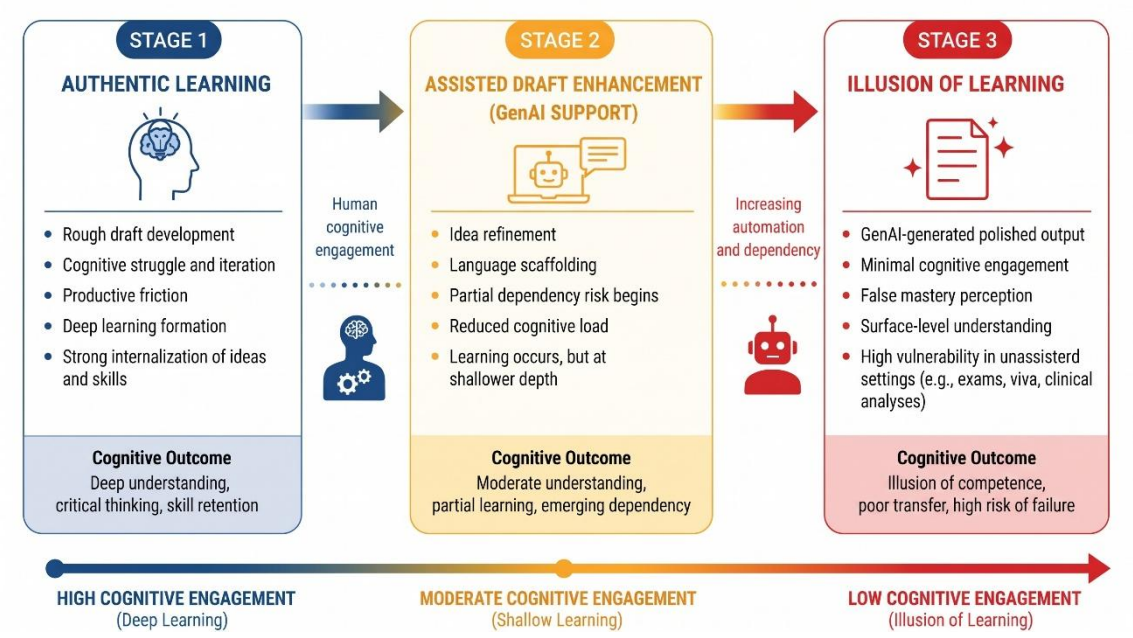

Fig. 5. Continuum of learning quality in GenAI-assisted academic writing

This continuum highlights that the primary disruption introduced by generative AI is not merely linguistic enhancement but a structural reconfiguration of the cognitive effort underpinning academic writing.

Furthermore, the pervasive ethical ambiguity and algorithmic anxiety identified in this study highlight the critical absence of structured AI literacy frameworks within contemporary foundation education. Relying on automated detection software as the primary mechanism for maintaining academic integrity has proven deeply problematic (Cotton et al., 2023). This approach creates a counterproductive climate of fear that penalises constructive linguistic experimentation while failing to address the deeper, latent issues of intellectual outsourcing (Chan & Hu, 2023). Particularly concerning is the pedagogical detriment to English as a Second Language (ESL) students, who feel compelled to intentionally degrade their own prose to avoid false-positive flags (Stone, 2024). This systemic failure underscores an urgent need for comprehensive curriculum reform across foundation science programmes. Higher education institutions must shift away from outdated, binary plagiarism paradigms and instead develop explicit, transparent, and discipline-

specific frameworks. These frameworks must clearly distinguish between constructive AI-assisted editing, such as grammar verification and structural outlining and unethical content generation, such as outsourcing entire literature syntheses or data interpretations (Ngo & Hastie, 2025). Ultimately, academic integrity must be reframed not as a passive compliance mechanism enforced by flawed algorithms, but as an active professional responsibility tied directly to clinical ethics and patient safety.

6. CONCLUSION

In conclusion, this preliminary qualitative case study demonstrates that foundation science students within the pre-pharmacy programme utilise generative AI extensively as an operational companion to navigate the linguistic and structural complexities of introductory academic writing (Rahmi et al., 2024). While the technology offers immediate benefits in vocabulary optimisation, localised syntax refinement, and cognitive scaffolding for ESL learners, its unguided and unregulated application ultimately fosters an instrumental dependency. This shift in academic writing practices has occurred more rapidly than institutions can comprehend or regulate, creating a critical imbalance between short-term technological convenience and long-term literacy development (Zhai et al., 2024). To protect the intellectual integrity of the pharmacy education programme, foundation science curricula cannot afford to remain passive, nor can they rely on reactionary bans.

The findings of this study highlight an urgent requirement for higher education institutions to design and implement structured, proactive AI literacy frameworks directly within pre-pharmacy foundation curricula. Rather than implementing ineffective technology bans or deploying faulty, anxiety-inducing automated detection tools, faculty must actively teach students how to utilise GenAI ethically, transparently, and critically. Furthermore, assessment methodologies must be redesigned to evaluate a student's real-time cognitive processing, original critical inquiry, and independent argumentative logic, rather than merely grading the polished, final written artefact (Ngo & Hastie, 2025). This can be accomplished by integrating synchronous oral defence components, mandatory reflective logs detailing student-AI prompting histories, and controlled, in-class synthesis tasks. While implementing these mechanisms in large pre-university cohorts presents notable time-management challenges for educators, streamlining assessments through concise peer-guided oral presentations, targeted sampling of reflective logs, or short timed in-class micro-writing tasks can ensure practical scalability. Without these targeted pedagogical interventions, a severe systemic risk remains that future cohorts will enter professional pharmacy programmes with a superficial, algorithmically dependent capability, fundamentally lacking the independent analytical depth required for safe, evidence-based clinical reporting.

Despite providing crucial empirical insights, this study possesses distinct limitations that must be acknowledged. As a qualitative case study bounded within a single public university foundation programme with a compact sample size (n = 12), these findings may not be immediately generalisable to structurally diverse educational or geographical contexts (Yin, 2018). Furthermore, the reliance on self-reported focus group data introduces the potential for social desirability bias, as students might misreport specific AI behaviours based on perceived peer or institutional expectations. Future research should address these limitations by expanding the geographic and institutional scope, incorporating multi-centred quantitative surveys across diverse public and private foundation programmes, and integrating direct longitudinal tracking of student writing portfolios over multiple academic years. Conducting longitudinal observations would allow researchers to track how pre-university AI habits condition student performance during clinical

rotations and final-year undergraduate research projects, thereby offering a more comprehensive understanding of GenAI's ultimate impact on scientific literacy within the healthcare workforce.

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CONFLICT OF INTEREST STATEMENT

The author certifies that the publication of this work is independent of any conflicts of interest or conflicting financial interests. This research was conducted independently in the author's academic capacity at the Centre of Foundation Studies, Universiti Teknologi MARA. The author has no financial, institutional, professional, or personal ties that would have affected the planning, execution, reporting, or interpretation of this study.

AUTHORS' CONTRIBUTIONS

Farhana Shukor: Conceptualisation, methodology, formal analysis, investigation, data curation, writing the original draft preparation, and writing the review and editing. The author read and approved the final manuscript.

DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

The author states that this manuscript was prepared using generative AI methods. During the writing process, ChatGPT (OpenAI) was utilised for structural support, linguistic improvement, and drafting assistance. Grammarly and QuillBot were utilised for language editing and grammatical verification. These tools were used solely for editing and language refinement. The study's conceptual framework, research data generation, data analysis, and interpretation were conducted entirely without the aid of AI tools. The final content of this work has been thoroughly reviewed and verified by the author, who takes full responsibility for the published article.

ETHICS STATEMENT

Ethical approval was subsequently granted by the Universiti Teknologi MARA (UiTM) Research Ethics Committee (Ref. No. REC/01/2025 [PG/MR/23]). All procedures complied with established institutional and international ethical standards.

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