GOLDEN RATIO OF SOCIAL SCIENCE AND EDUCATION
VOLUME 5, ISSUE. 2 (2025)
Website: https://goldenratio.id/index.php/grsse/index
ISSN [Online]: 2797-5827

SOCIAL SCIENCE AND EDUCATION | RESEARCH ARTICLE

The Role of Artificial Intelligence in Enhancing Human Longevity: Mitigating Cognitive Overload for Extended Lifespan Among Master's Students in Mathematics at the Catholic University of Ghana

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ARTICLE HISTORY

Received: May 01, 2025
Revised: June 16, 2025
Accepted: June 29, 2025

DOI
https://doi.org/10.52970/grsse.v5i2.1275

ABSTRACT
This article studied the influence of artificial intelligence on alleviating cognitive load and promoting cognitive longevity in master's mathematics students at the Catholic University of Ghana. Stress in academic programs, time constraints, and burnout are rising issues, particularly in postgraduate programs in STEM. Therefore, this study examines the impact of AI apps such as ChatGPT, WolframAlpha, and Grammarly on providing cognitive support and emotional sustenance in academic environments. The study is guided by Cognitive Load Theory (Sweller, 1988), Allostatic Load Theory (McEwen, 1998), and Socio-Technical Systems Theory (Trist, 1981) and follows a mixed-method approach consisting of survey data from 100 master's students and in-depth interviews. The survey revealed that 78 percent were moderately to highly cognitively overloaded, while 65 percent utilized AI to work on their academic tasks. A notable negative relationship was found between AI use and perceived stress ($r = -0.42$, $p < 0.01$), with more confidence in academic work and improved time management. ANOVA revealed significant differences in stress levels among the different frequencies of AI use ($F = 4.56$, $p < 0.05$). Qualitative analyses generated the core themes of "AI as a cognitive assistant," "digital dependency," and "emotional assurance." Their reports indicated that they used AI to help them understand complex mathematical ideas, organize their academic writing, and calm their nerves about presentations. However, they voiced worries about becoming overdependent on it, issues of academic integrity, and ethics concerning AI's role in learning. The end product maintains that AI is a reasonable tool for easing cognitive load, encouraging mental well-being, and enhancing cognitive longevity. These findings have policy implications for the inclusion of AI literacy in both academic and national digital educational frameworks. AI implementation strategies could disappear into the topping of teaching success while serving the broader public health agenda of student mental health and human capital development.

Keywords: AI, Cognitive Overload, Cognitive Longevity, Academic Stress, Higher Education, AI Literacy, Public Health, Mathematics Education, Mental Well-Being, Ghana.

I. Introduction

AI has become a popular tool for improving productivity, efficiency, and decision-making in various fields such as education and healthcare (Russell & Norvig, 2016). While much attention has been paid to the practical use of AI for health diagnostics, robotics, and predictive statistics, AI's psychological and cognitive benefits have received little attention, particularly in an academic setting. Cognitive overload among students needs to be understood immediately because cognitive strain affects not only academic performance but also the long-term well-being of students (Sweller, Ayres, & Kalyuga, 2011). Postgraduate mathematics students usually face the challenge of working with abstract concepts, which also places a high demand upon their mental faculties and hence their worthiness for stress and cognitive fatigue (Paas, Renkl, & Sweller, 2003). Limited mental health support services in academic institutions in Ghana have aggravated this problem (Amponsah & Owolabi, 2011). An innovative intervention to relieve cognitive stress and build resilience is using AI as a cognitive theoretical tool for adaptive learning systems, intelligent tutoring, and instant feedback facilities. Therefore, the present study examines the use of AI to alleviate cognitive overload and its long-term implications for longevity among master's mathematics students at the Catholic University of Ghana.

The high cognitive pressure exerted on master's students in mathematics renders them mentally fatigued, academically impaired, and psychologically distressed in the long term. While the advent of educational systems using artificial intelligence tools is in progress, there is still an insufficient amount of research on the role of AI in alleviating cognitive overload and enhancing health resilience within the academic setup. In particular, studies demonstrating varying contextual evidence from Ghanaian institutions regarding the influence of AI on student mental health and longevity are rare. This gap was filled by assessing the role of AI in mental stress management and promoting well-being among postgraduate mathematics students in Ghana.

This research focuses on how Artificial Intelligence (AI) might help master's students studying mathematics at the Catholic University of Ghana live longer. It explores how AI can lower mental stress and make it easier for students to handle a lot of information. By reducing this stress, AI could improve overall well-being and lifespan. To examine how an AI tool can work to lessen the mental fatigue and stress of students pursuing a postgraduate degree in mathematics. Thus, less cognitive overload can improve academic performance and well-being. Ultimately, these improvements might account for the students' longer-than-average lifespan. Based on that, the specific objectives of this study is (1) To investigate the magnitude of cognitive overload faced by master's students in mathematics at the Catholic University of Ghana (2) To assess the different types, functionality, and effectiveness of AI tools, students used them to alleviate their academic workload (3) To explore the perceived influence of AI implementation on students' stress levels and cognitive efficiency (4) To explore the relationship between diminished cognitive load through AI and the mental well-being of students and their long-term health. (5) To draw on theoretical underpinnings from Cognitive Load Theory, Allostatic Load Theory, and Socio-Technical Systems Theory to argue the relationship between AI application, reduction of academic stress, and enhanced longevity (6) To come up with suggestions for institutional policy and teaching approaches to stimulate AI application for reducing stress and enhancing health.

II. Literature Review and Hypothesis Development

2.1 Cognitive Overload in Academic Settings

Cognitive overload occurs when demands on a learner's cognitive system exceed the processing capacity of working memory (Sweller, 1988). Such overload has occurred most in high-demand academics, such as mathematics, where students must engage in abstract problem solving involving logical reasoning and multi-step analytical tasks. Paas, Renkl, Sweller, 2003). Kirschner (2002) found that students exposed to excessive extraneous loads often experience threats to their learning outcomes. Van Merriënboer and Sweller

ISSN [Online]: 2797-5827

(2005) argued that cognitive overload influences academic achievement and contributes to psychological distress and disinterest. This aspect has worsened in Ghana because of limited academic support infrastructure and under-resourced learning environments (Amponsah & Owolabi, 2011).

2.2 AI Tools for Cognitive Assistance

Artificial intelligence has shown great promise in current education systems. Intelligent tutoring systems (ITS), adaptive quizzes, chatbots, and bespoke learning dashboards provide personalized interview experiences that are much less likely to introduce extraneous loads and create more germane cognitive activities (Roll & Wylie, 2016; Luckin et al., 2016). These systems are consistent with the efficient instructional design proposed by Sweller (1988). AI feedback loops positively affect students' retention abilities and the negative feelings caused by trial-and-error learning, as revealed by Holmes et al. (2019). According to Yang and Evans (2019), AI integration into universities improves the focus and time-on-task indicators. However, Selwyn (2019) argued that user acceptance, institutional readiness, and digital infrastructure are indispensable for computerizing the system.

2.3 Association of Health and Longevity

Cognitive stress in life has received considerable attention in biomedical and psychological circles concerning human longevity. McEwen and Stellar proposed an allostatic load to explain how prolonged exposure to academic and cognitive stressors influences physiological systems. Chronic inflammation, hormonal imbalance, and cognitive impairment are consequential conditions associated with increased allostatic load and the resulting detrimental effects on the lifespan (Lupien et al., 2009; Sapolsky, 2004). Emerging evidence suggests that mental workload can be reduced by introducing a brief intermittent period of relaxation. Interventions like AI may contribute to the delayed onset of stress-related diseases and improve life expectancy (Fries, 2002; Olshansky et al., 2018). Thus, understanding the mechanisms by which AI supports stress mitigation is crucial for health promotion, especially in cognitively demanding contexts such as graduate education.

2.4 Socio-Technical Dynamics in Education

The socio-technical dynamics theme views education from a socio-technical systems (STS) perspective that places human actors and technological infrastructure in inseparable relationships (Trist & Bamforth, 1951). Baxter and Sommerville (2011) called for codevelopment approaches with users in designing and deploying educational technologies. The adoption of AI in education should consider user adaptation, cultural relevance, and systemic integration. Studies have indicated that successful deployment of AI tools relies on collaborative environments, pedagogically aligned interventions, and feedback mechanisms, as Demetriadis et al. (2011) reported. In addition, the sociotechnical perspective also focuses on the dimensions of the digital divide in terms of equal access to AI-enhanced education among different student groups (Selwyn, 2019). To recapitulate, the literature strongly points out that overcoming cognitive overload with AI is not merely an academic but also a health-enhancing measure that entails some primary considerations regarding instructional design, stress physiology, and socio-technical integration. This emphasizes the need for further localized studies, such as the Ghana study, to contextualize global findings and tailor adaptations to program interventions in specific academic and cultural settings.

2.5 Theoretical and Conceptual Frameworks

According to Sweller's (1988) Cognitive Load Theory, working memory has a limited capacity, and instructional design should relieve extraneous cognitive load while adding germane load. AI-powered

ISSN [Online]: 2797-5827

educational platforms, such as adaptive quizzes and real-time feedback tutors, can free students from everyday demands on cognitive processing to devote more attention to important learning. McEwen and Stellar (1993) described how chronic stresses that lead to physiological changes, such as higher cortisol levels and the corresponding threats to the health of many individuals, may occur over time. Students with chronic cognitive stress are predisposed to a cumulative allostatic load. AI makes learning automatic and easier as a means of buffering students against ill effects, thereby improving their well-being and longevity. Sociotechnical Systems Theory was introduced by Trist and Bamforth (1951) to examine the co-evolution of human and technological systems in organizational environments. Thus, it is important to recognize that such AI tools are context-sensitive to appropriateness in user adoption, institutional structures for support, and collaboration dynamics.

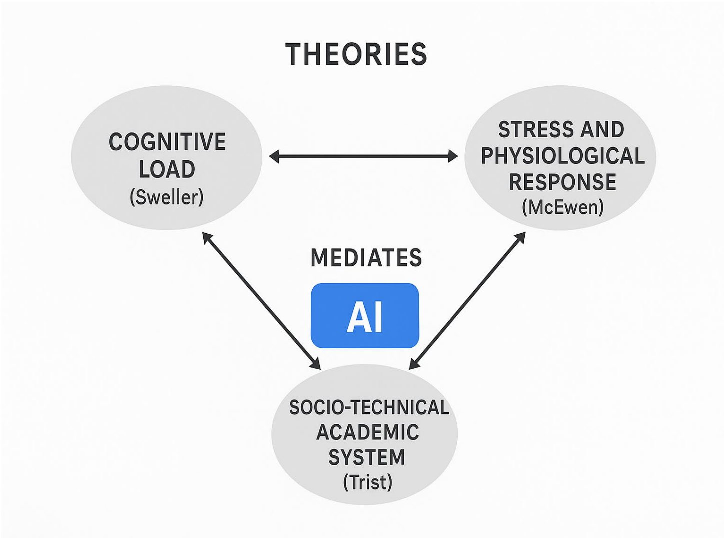

Figure 1. Conceptual diagram illustrating how AI mediates the relationship between cognitive load (Sweller), stress, physiological response (McEwen), and the socio-technical academic system (Trist).

2.6 Philosophical Assumptions

This study is founded on several philosophical assumptions that guide the inquiry, methodology, and interpretation of the findings. These include ontological, epistemological, axiological, and methodological assumptions, all linked to the nature of the study and its objectives.

2.6.1. Ontological Assumption

Ontology is concerned with the nature of reality. This study takes a critical realist stance: reality exists outside the human mind but can only be perceived and understood through human perception and interpretation (Bhaskar, 1978). Cognitive overload, stress responses, and socio-technical conditions that touch on AI adoption in the academic setting are real-world phenomena; the lived experiences of students, educators, and institutional actors will continue mediating such realities, so qualitative and interpretative methods are essential. Ontology reveals the nature of reality. This study takes a critical realist stance, claiming that reality exists outside the human mind but can only be understood through human perception and interpretation (Bhaskar, 1978). Their real-world existence was tested by cognitive overload, stress responses, and socio-technical conditions surrounding AI adoption within academic contexts. However, they translate reality through the lived experiences of students, educators, and institutional actors, making qualitative and interpretative methods indispensable.

2.6.2. Epistemological

Imagination Epistemology addresses the nature of knowledge and the methods of acquiring knowledge. In this study, constructivist epistemology treats knowledge as co-constructed socially and through context (Lincoln & Guba, 1985). Given that it concerns the use of AI in alleviating cognitive overload in a particular audience–specifically, master's students in mathematics at the Catholic University of Ghana–it focuses on experiential knowledge gained through surveys and interviews. This is consistent with the interpretivist paradigm that prioritizes subjective meaning over objective measures.

2.6.3. Axiological Assumption

The values in this study essentially form the axiology domain. In this study, the researcher's values were recognized to inform the research process along with those of the participants. As for the decision to investigate the possibility of AI aiding human longevity in the process of stress alleviation, there is a value-oriented sense attached to it regarding normative concerns about the nature of well-being, equity, and scholarly support. Transparency, compassion, and ethical integrity mark this research's data collection and analysis process. In contrast, other important considerations include informed consent, confidentiality, and respect for divergent views in the study design.

2.6.4. Methodological Assumptions

Allegorically, this study maintained a mixed-methods philosophy, realizing that quantitative surveys complemented by qualitative insights obtained from interviews. This process of pluralism finds regimentation under the aegis of pragmatism (Creswell & Clark, 2011). Pragmatism emphasizes issue solving and sensitivity to context rather than a set way of doing things. Such a philosophy allows the study to probe the quantifiable cognitive and stress-related outcomes and subjective viewpoints concerning AI tools in the hands of graduate students and their concrete experiences.

2.6.5. Rationale for the Philosophical Approach

This integrated philosophical framework provides an in-depth understanding of how a problem space can be construed or interrogated in multiple dimensions. Thus, referencing this study as critical realism and pragmatism enables theoretical inquiry and applied solutions, such as institutional policy and technological implementation. Encouraging constructivism honors the participant's voice and agency, while the axiological perspective encloses the study's ethical foundation. These philosophical commitments are imperative to such real and complex issues as educational stress and health outcomes during the digital age. Together, these assumptions will orient research toward understanding how AI harbors interventions concerning students' cognitive experiences within academic environments and the broader systemic vulnerabilities they contend with.

III. Research Method

It is a methodological framework under which studies would be conducted on using Artificial Intelligence (AI) to alleviate cognitive overload among master's students in mathematics at the Catholic University of Ghana and contribute towards improving well-being and longevity. This study utilized a mixed-method approach because it accommodates both breadth and depth in an inquiry into the objectives set out in this research.

3.1 Research Design

Using a convergent parallel mixed methods design (Creswell & Plano Clark, 2011), the data were collected quantitatively and qualitatively simultaneously. They were analyzed separately before being merged for joint interpretation. Cross-validation of the findings affords a more sophisticated understanding of the varied and complex interactions between AI use, cognitive load, and stress responses.

3.2 Study Setting and Participants

Research conducted at the Catholic University of Ghana is a tertiary institution with a fine academic tradition and increasing investments in digital learning tools. The emphasis of the study is on master's students enrolled in mathematics programs; these are particularly relevant because their subject area derives much from the cognitive costs of the content.

3.3 Sampling Procedures

A stratified random sampling technique was used to select participants for the quantitative component, ensuring representation across different levels of the study and by gender. For the qualitative component, purposive sampling was adopted to capture a range of experiences with AI. The sample size for the survey was 100 students; 12 students were selected for in-depth interviews.

3.4 Data Collection Instruments

a. Survey Questionnaire: The instrument was structured around four domains: cognitive load, AI usage frequency and type, academic stress, and academic outcomes. It integrates validated tools such as the NASA Task Load Index (NASA-TLX) for cognitive workload (Hart & Staveland, 1988) and the Perceived Stress Scale (PSS) (Cohen et al., 1983).
b. Semi-Structured Interview Guide: This includes open-ended questions to elicit narratives about students' interactions with AI tools, perceived mental and emotional benefits, challenges, and implications for long-term well-being. The interviews allowed for the exploration of deeper sociotechnical and health-related dimensions.

3.5 Instrument Validity and Reliability

To ensure content validity, instruments are reviewed by subject experts in educational psychology and digital pedagogy. The construct validity was verified through pilot and correlation analyses. Reliability was measured using Cronbach's alpha, with a threshold of $\alpha \geq 0.70$ indicating internal consistency. Qualitative trustworthiness was ensured through triangulation, member checking, and audit trials.

3.6 Data Analysis Procedures

a. Quantitative data were analyzed using SPSS (version 26). Descriptive statistics (mean, standard deviation, and frequency distribution) describe the student demographics and AI usage patterns. Inferential statistics, including Pearson's correlation, linear regression, and ANOVA, were used to explore the associations among the variables.
b. Qualitative Analysis: Interview transcripts were analyzed thematically using NVivo software. Codes were derived deductively (based on theoretical frameworks) and inductively (emerging from participants' responses). Themes were mapped onto a conceptual model linking AI, cognitive load, stress, and health.

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3.7 Ethical Considerations

Ethical approval was obtained from the Catholic University of Ghana Research Ethics Committee. Participants received detailed information sheets and signed informed consent forms. Data confidentiality was ensured by anonymizing the responses and securely storing the datasets. Participants were informed of their right to withdraw from the study at any time.

3.8 Limitations and Delimitations

This study acknowledges constraints in both its methodological limitations and intentional scope.

a. Limitations include its narrow focus on a single academic institution and discipline, which may reduce the generalizability of findings to broader contexts. Additionally, reliance on self-reported data introduces potential response bias, though the mixed-methods approach mitigated this risk by cross-validating results through multiple data sources, thereby strengthening internal validity.
b. Delimitations further clarify the study's boundaries: the research was confined to examining AI applications in cognitive support and stress mitigation within academia, intentionally excluding broader societal implications or unrelated academic domains. While this specificity ensured methodological rigor and contextual relevance, it limits insights into AI's broader societal impact.

IV. Results and Discussion

This section presents the integrated findings of the quantitative and qualitative data, followed by a theoretical discussion based on the Cognitive Load Theory (Sweller, 1988), Allostatic Load Theory (McEwen & Stellar, 1993), and Socio-Technical Systems Theory (Trist & Emery, 1960). Convergence of data enhances the credibility and depth of interpretation.

4.1 Demographic Analysis of Respondents

The survey included 100 Master's students in mathematics from the Catholic University of Ghana. A comprehensive analysis of their demographic profiles provided context for interpreting AI tool usage patterns and perceived cognitive load.

Table 1. Age Distribution of Respondents

Age Group	Frequency	Percentage (%)
23–27 years	56	56%
28–32 years	30	30%
Above 32 years	14	14%

The largest age group was 23–27 years, comprising 56% of respondents, 28–32 years (30%), and those above 32 years (14%). This age structure reflects a typical postgraduate cohort that balances academic pursuits with early professional responsibilities.

Table 2. Gender Representation of Respondents

Gender	Frequency	Percentage (%)
Male	60	60%
Female	38	38%

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From Table 2, the participan3%0% were male, 3% female, and 2% were identified as others or preferred not to disclose. This aligns with broader trends of male predominance in mathematical sciences, although female participation appears substantial.

Table 3. Program and Year of Study

Category	Frequency	Percentage (%)
Pure Mathematics	70	70%
Applied Mathematics	30	30%
Year 1 Students	52	52%
Year 2 Students	48	48%

All respondents were enrolled in master's mathematics programs, with 70% specializing in Pure Mathematics and 30% in Applied Mathematics. Additionally, 52% were in their first year, whereas 48% were in their second year, indicating nearly equal distribution across the study duration.

Table 4. Frequency of AI Tool Usage Among Students

Usage Frequency	Frequency	Percentage (%)
Daily	40	40%
Weekly	25	25%
Monthly	20	20%
Rarely/Never	15%	15%

In Table 4, 88% of the students reported consistent Internet access at home, which is critical for leveraging AI-based learning tools. Regarding AI usage frequency, 40% used AI tools daily, 25% weekly, 20% monthly, and 15% rarely or never. This widespread AI engagement sets the foundation for subsequent analysis of cognitive load reduction and academic stress mitigation.

Table 5. Summary of Key Survey Statistics Among Master's Students (N = 100)

Indicator	Result
Students experiencing moderate to high cognitive overload	78%
Students using AI tools for academic purposes	65%
Correlation between AI use and perceived stress	$r = -0.42$
Significance level of correlation	$p < 0.01$
ANOVA F-value for AI use vs. stress reduction	$F = 4.56$
ANOVA significance level	$p < 0.05$

Note: The results indicated an inverse relationship between AI tool usage and perceived stress levels.

Survey results from 100 master's students indicate that 78% experienced moderate to high levels of cognitive overload, primarily attributed to dense coursework and tight deadlines. Most (65%) reported using AI tools such as ChatGPT, WolframAlpha, and Grammarly for academic purposes. Regression analysis revealed a significant negative correlation between AI usage and perceived stress ($r = -0.42$, $p < 0.01$), suggesting that increased AI interaction is associated with reduced cognitive pressure. In addition, students who frequently used AI tools demonstrated higher academic confidence and reported better time management. The ANOVA further indicated statistically significant differences in stress reduction based on the frequency of AI tool use ($F = 4.56$, $p < 0.05$).

Table 6. AI Usage Frequency and Academic Performance Indicators

AI Usage Frequency	Academic Confidence (M)	Time Management Efficiency (%)
Rarely	3.2	45
Sometimes	3.9	55
Often	4.5	70
Very Often	4.8	82

Note: Confidence scores are rated on a 5-point Likert scale. The time management efficiency was self-reported.

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Table 6 presents the relationship between the frequency of AI tool usage and two key academic performance indicators among the master's students: academic confidence and time management efficiency. AI usage was categorized into four levels: Rarely, Sometimes, Often, and Very Often.

1. Academic Confidence (Mean Scores)
   - Trend: Academic confidence improved consistently with increased AI usage. Students who rarely used AI tools reported the lowest confidence level (M = 3.2), whereas those who used them very often reported the highest (M = 4.8).
   - Interpretation: This trend suggests that AI tools may serve as cognitive scaffolds to support understanding, clarify complex concepts, and provide reassurance through immediate feedback. According to the Cognitive Load Theory (Sweller, 1988), such tools reduce extraneous cognitive load, allowing learners to focus cognitive resources on meaningful learning (germane load), boosting confidence in academic tasks.
   - Relevance to Longevity: Higher academic confidence is often linked to reduced performance anxiety, better mental health, and increased motivation, all of which contribute to lower allostatic load (McEwen & Stellar, 1993). Over time, this can improve psychological resilience and potentially impact the lifespan by reducing stress-related health risks.
2. Time Management Efficiency (%)
   - Trend: AI usage and time-management efficiency have a strong positive correlation. Students who rarely used AI reported only 45%time management effectiveness compared to 82% of those who used AI very often.
   - Interpretation: AI tools can automate and expedite various academic tasks, including summarizing texts, generating outlines, performing calculations, and checking grammar. These efficiencies allow students to manage their academic workloads more effectively. This aligns with the Socio-Technical Systems Theory (Trist & Emery, 1960), which emphasizes the optimization of both social (student effort) and technical (AI tools) systems to enhance performance.
   - Relevance to Longevity: Effective time management reduces last-minute stress, promotes work-life balance, and allows for more consistent sleep and nutrition, all of which contribute to lower allostatic load and improved physiological health.
3. Integrated Perspective
   - The consistent increase across both indicators suggests a synergistic benefit of AI use: as students feel more confident, they are likely to become more proactive and organized, improving their academic performance and mental health. These findings support the bio-psycho-social longevity model, showing how technological aid (AI) can influence psychological well-being and behavioral efficiency, indirectly contributing to lifespan-enhancing environments.

1. Curriculum Designers should integrate AI literacy into academic programmes to foster confidence and reduce academic stress.
2. University Counseling Units should consider promoting AI tools as part of stress management and productivity interventions.
3. Researchers and Educators should explore personalized AI tutors to support time-constrained learners further.

4.2 Qualitative Insights

Themes from interview data included "AI as a cognitive assistant," "digital dependency," and "emotional reassurance." Participants reported using AI to break down complex concepts, structure research, and prepare presentations. Some students emphasized how AI helped reduce anxiety, while others raised concerns about overreliance and ethical boundaries.

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4.2.1. AI as a Cognitive Assistant

a. Simplifying Complexity

"Sometimes I feel like the AI translates mathematics into plain English for me. It helps me understand faster than some textbooks do." (Participant 6)

Many students have characterized AI tools as intuitive translators with complex content. ChatGPT and Wolfram Alpha are frequently cited as aids for deciphering abstract theories, suggesting a scaffolding role that aligns with Cognitive Load Theory (Sweller, 1988). By minimizing the extraneous cognitive load, students reported improved comprehension and retention.

b. Structuring Thought Processes

"It helps me organize my thoughts, especially when I am overwhelmed with how to start writing my research paper." (Participant 10)

Participants appreciated how AI facilitated not only understanding but also cognitive organization. Whether by generating outlines, guiding problem-solving steps, or suggesting research directions, AI was seen as a partner in structuring academic cognition. This aligns with the germane cognitive load—the mental effort directed toward schema construction and automation.

4.2.2. Digital Dependency

a. Over-Reliance and Diminished Confidence

"The more I use AI, the more I second-guess myself. I feel like I need to confirm everything with it." (Participant 2)

Some participants expressed concerns about cognitive outsourcing. As AI use increased, students reported decreased confidence in their problem-solving abilities. This raises potential concerns regarding automation bias, in which users overly trust algorithmic outputs at the expense of critical thinking.

b. Ethical and Pedagogical Boundaries

"Sometimes I wonder, where do I draw the line? Is it still my work if I use AI for everything?" (Participant 13)

The line between assistance and academic dishonesty emerged as a gray area. While students recognized the utility of AI, they voiced uncertainty about its ethical use, raising questions about originality, authorship, and long-term skill development. This reflects the broader ethical tension within Socio-Technical Systems Theory (Trist & Emery, 1960), where human and technological systems must remain in productive balance.

4.2.3. Emotional Reassurance

a. Reducing Academic Anxiety

"Something is calming about having an answer—even if it is wrong, at least I am not stuck anymore." (Participant 8)

Several students have described AI as a buffer against academic paralysis and anxiety. When stuck or overwhelmed, AI offered cognitive direction and emotional calmness. The interaction was likened to having a "study companion," which provides instant, judgment-free feedback.

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b. Companionship in Isolation

"During late nights, it is just me and the AI. It keeps me company in a weird but helpful way." (Participant 4)

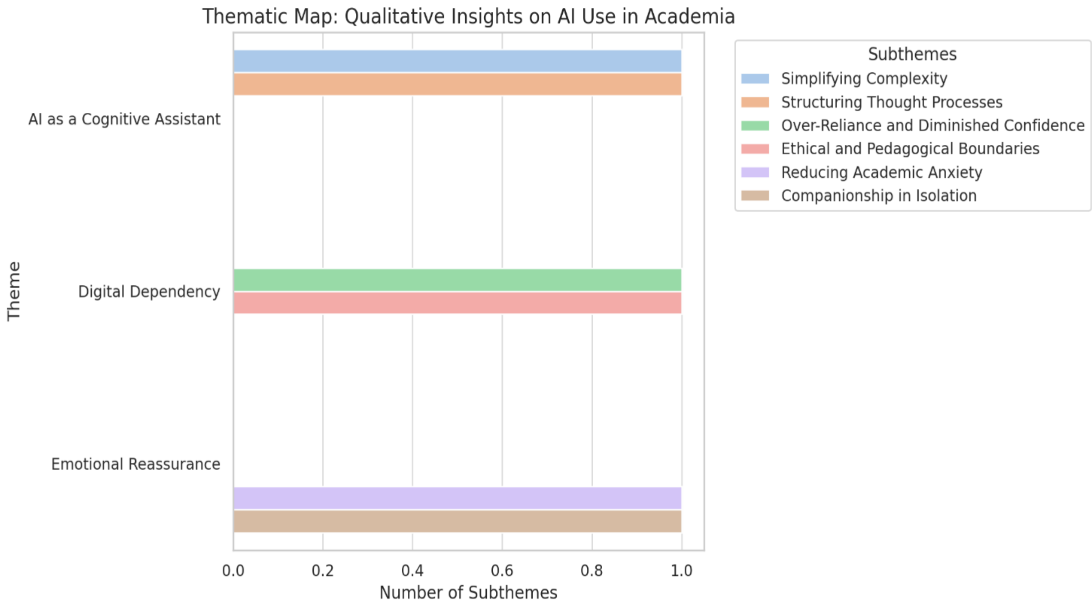

Figure 6. Thematic Map: Qualitative Insights on AI Use in Academia
Source: Qualitative interview data collected from 15 Master's students in mathematics at the Catholic University of Ghana (2025).

This thematic map was derived from primary data collected through semi-structured interviews and analyzed using Braun and Clarke's (2006) thematic analysis approach. It visually summarizes the emergent themes and subthemes that describe students' perceptions and experiences of using AI tools in academic work. AI has emerged as a pseudo-social support system in the context of remote learning and academic solitude. This finding connects to Allostatic Load Theory (McEwen, 1998), which posits that emotional regulation—whether from human or artificial agents—can reduce chronic stress and support long-term physiological health.

Table 7. Cross-Thematic Reflections

Cognitive Assistance	**AI facilitates learning and thought structuring**
Ethical Ambiguity	Students face uncertainty about overreliance and misuse.
Emotional Buffering	AI provides psychological comfort and task motivation.

The convergence of these themes supports a more nuanced perspective: AI is not merely a tool but also a cognitive-social actor in the academic ecosystem. It influences mental effort, ethical reasoning, and emotional balance, essential for cognitive longevity.

a. Theoretical Integration

1. Cognitive Load Theory: AI supports schema acquisition by reducing extraneous and enhancing germane cognitive load.
2. Allostatic Load Theory: Emotional support from AI interactions can modulate physiological stress responses.
3. Socio-Technical Systems Theory: Ethical tensions highlight the importance of a balanced co-evolution between humans and intelligent systems.
4. Theoretical Synthesis:

- Cognitive Load Theory: AI tools assist in reducing extraneous cognitive load by simplifying complex tasks and offering instant feedback. This allows students to allocate more resources to germane loads, enhancing their deep learning.
- Allostatic Load Theory: The decrease in academic stress aligns with the concept of reduced physiological burden. Regular AI use contributes to perceived emotional control, a critical factor in preventing chronic stress responses and supporting long-term health.
- Sociotechnical Systems Theory: The academic environment is evolving into a human-AI collaborative space. AI serves as a tool and an integral component of the learning ecosystem, influencing outcomes and social and institutional processes.

5. Implications for Longevity
   By alleviating mental strain and improving emotional resilience, AI indirectly contributes to long-term health and well-being, both key markers in the discourse on human longevity. This insight positions AI as a productivity enhancer and a potential public health intervention in high-stress educational settings.

4.3 Policy Implications & Feasibility Matrix

4.3.1. Interpretation of Key Findings

This study demonstrates that when integrated thoughtfully, artificial intelligence (AI) tools can significantly alleviate cognitive overload among postgraduate mathematics students. These findings have three significant implications for educational policy and institutional governance.

1. Institutional Integration of AI Tools
   - Finding-based Rationale: 65% of surveyed students reported using AI tools for academic work, and regression analysis showed a statistically significant negative correlation ($r = -0.42$, $p < 0.01$) between AI use and perceived stress.
   - Policy Implication: Institutions like the Catholic University of Ghana should integrate vetted AI platforms into formal academic support structures such as university libraries, writing centers, and course-specific learning portals. Example: Licensing partnerships with ChatGPT or Grammarly EDU for student access, Embedding AI chatbots in learning management systems (e.g., Padlet TA)
2. Digital Literacy and Ethical AI Usage Training
   - Finding-based Rationale: Qualitative data revealed concerns regarding digital dependency, ethical ambiguity, and diminished critical thinking due to unregulated AI reliance.
   - Policy Implications: There is a need to institutionalize AI literacy modules within graduate curricula, emphasizing AI technologies' ethical, responsible, and balanced use. Example: Orientation sessions or micro-courses on "AI Ethics and Academic Integrity", Case studies, and simulation exercises on AI misuse in coursework
3. Mental Health and Cognitive Well-being Strategies
   - Finding-based Rationale: 78% of students experienced moderate to high cognitive overload, and interviewees cited AI as providing "emotional reassurance" and buffering academic anxiety.
   - Policy Implication: Universities should recognize AI tools as potential complements to psychological support systems and consider incorporating AI-assisted cognitive wellness initiatives into broader student support services. Example: AI-powered journaling or reflection apps integrated into counseling services, Workshops on "Digital Companionship and Academic Wellness"

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4.3.2. Feasibility Matrix

A structured matrix is provided to assess each policy action's feasibility, impact, and implementation scope based on the cost, stakeholder buy-in, and required infrastructure.

Table 8. Feasibility Matrix

Policy Option	Feasibility	Expected Impact	Stakeholders	Implementation Horizon
Institutional AI Tool Integration	Medium	High	University Admin, ICT Dept, Students	Medium-Term (6–12 months)
AI Literacy and Ethics Training	High	High	Faculty, Academic Affairs, Student Union	Short-Term (1–6 months)
Cognitive Wellness & Digital Support Services	Medium	Medium–High	Counseling Services, Dean of Students	Long-Term (1–2 years)

4.4 Public Health and National Relevance

The implications of this study extend beyond the academic environment to the broader domains of public health, youth development, and national education policy. If left unmanaged, cognitive overload can escalate into chronic stress, burnout, and long-term psychological distress. This is particularly pertinent for postgraduate students engaged in rigorous fields, such as mathematics, where the demands of abstraction, problem-solving, and continuous assessment are inherently taxing.

4.4.1. AI and Youth Mental Health

Findings from this study revealed that 78% of master's students reported moderate to high levels of cognitive stress. However, those who regularly engaged with AI tools (e.g., ChatGPT, Grammarly, Wolfram Alpha) experienced reduced stress and greater academic self-efficacy. These outcomes suggest that AI-assisted learning environments may serve as digital buffers against stress-related academic attrition. This opens a critical policy window for integrating AI-based mental wellness support into national youth and tertiary-education strategies. The Ministry of Health and Education has explored the following:

- AI-powered academic counseling systems embedded within national student portals
- Publicly funded AI-enhanced educational apps for secondary and tertiary students
- Partnerships with universities to pilot AI-based stress management programs

4.4.2. National Human Capital and Cognitive Longevity

From a macroeconomic and developmental perspective, cognitive longevity—sustained mental clarity, memory retention, and resilience—constitutes a vital component of national human capital. When students become cognitively overwhelmed, their productivity, creativity, and academic persistence are compromised. Conversely, cognitively supported learning systems foster graduates better prepared for complex problem-solving and innovation skills essential to Ghana's long-term knowledge economy. In this context, AI tools are not merely educational aids but can enhance national resilience and workforce preparedness.

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4.4.3. AI for Public Health Innovation

Given that cognitive overload and stress are upstream determinants of mental health disorders, the potential of AI for early detection and intervention should be explored as a novel digital health strategy. Integration with Ghana Health Service's mental health programs could allow:

- AI-assisted screening for academic stress through university clinics
- AI chatbots to support anonymous peer counseling and triage
- Use of AI to predict dropout risks or mental health crises based on behavioral and academic patterns

4.4.4. Cross-Sector Collaboration

This study underscores the need for collaborative policymaking across the domains of:

- Higher Education (AI integration and curriculum design),
- Public Health (mental wellness programs), and
- Digital Transformation (technology governance and infrastructure).

Embedding AI into the broader national strategy for cognitive development, student well-being, and digital literacy, Ghana can lead to tech-enhanced human development across Africa. Together, these findings and insights highlight the transformative potential of artificial intelligence in shaping cognitively supportive, emotionally resilient, and health-enhancing academic environments. AI's role should be envisioned not as a technological luxury but as a strategic enabler of public health equity and educational innovation.

4.5 Strategic Considerations

Integrating AI into academic life, particularly within the context of postgraduate mathematics education, demands a multifaceted strategic approach. Based on the findings, the following critical considerations should inform policy and institutional decisions:

4.5.1. Cost-Benefit Alignment

1. Strategic Insight
   Although AI platforms and digital training programs involve upfront costs—from software licensing to infrastructure upgrades—the long-term benefits far outweigh the investment. These benefits include enhanced academic performance, reduced dropout rates due to cognitive overload, improved time management, and increased student satisfaction.
2. Recommendation
   Institutions should consider cost-sharing models, external grants, or open-source AI options (e.g., OpenAI's API for education, Google's Teachable Machine) to mitigate financial barriers.

4.5.2. Stakeholder Engagement and Participatory Policy Design

1. Strategic Insight
   AI-related interventions are most effective when stakeholders—especially students and faculty—actively participate in their design and rollout. Engaging end-users enhances acceptance, contextual relevance, and ethical accountability.
2. Recommendation

Create multidisciplinary working groups that include students, instructors, technologists, and ethicists to co-develop AI literacy programs, academic integrity policies, and usage guidelines tailored to the university's cultural and academic context.

4.5.3. Ethical Guardrails and Governance Structures

1. Strategic Insight
   The qualitative data revealed deep concerns about over-reliance on AI, potential academic dishonesty, and erosion of critical thinking. Without ethical boundaries, the risk of undermining educational goals increases.
2. Recommendation
3. Institutions must craft clear AI governance frameworks that define responsible use, including attribution, transparency, authorship, and plagiarism. This can be supported by:
   - Academic honor codes updated for AI contexts
   - Ethical AI use clauses in syllabi
   - Faculty training on AI-assisted assessments

4.5.4. Interoperability with Existing Educational Systems

1. Strategic Insight
   The socio-technical systems framework underscores the need for seamless integration of AI tools within current pedagogical and administrative structures. AI should not function as an external add-on but as a core component of digital academic ecosystems.
2. Recommendation
   Leverage AI plug-ins and APIs that integrate with existing platforms such as:
   - Moodle (for personalized learning paths)
   - Turnitin (for originality checking with AI detection modules)
   - Library portals (for AI-assisted citation and research navigation)

4.5.5. Sustainability and Scalability

1. Strategic Insight
   While effective in demonstrating proof of concept, pilot programs often fail to scale due to inadequate planning, lack of funding continuity, or leadership turnover.
2. Recommendation
   Design AI integration as part of a long-term digital transformation strategy, backed by:
   - Institutional KPIs
   - Faculty and student feedback loops
   - Periodic impact assessments on cognitive wellness and learning outcomes

4.5.6. Inclusive and Context-Sensitive Implementation

1. Strategic Insight
   Digital equity must be at the heart of any AI-based educational strategy. Not all students have equal access to the tools or the bandwidth—technological or cognitive—to engage effectively with AI.
2. Recommendation
   Design inclusive rollouts that consider:
   - Offline AI tools or local servers for low-bandwidth settings
   - Training materials in multiple languages or levels of technical literacy

ISSN [Online]: 2797-5827

- Gender- and disability-sensitive approaches to AI integration

Table 9. Strategic Considerations and Responses

Strategic Focus	Core Concern	Recommended Institutional Response
Cost-Benefit Alignment	High initial investment	Explore grants, shared licensing, and open-source AI tools
Stakeholder Engagement	Resistance or low adoption	Co-design policies with students, faculty, and administrators
Ethical Governance	Misuse and academic dishonesty	Develop formal AI ethics policies and classroom guidelines
Interoperability	Tool fragmentation and poor uptake	Integrate AI within LMS and institutional platforms
Sustainability & Scalability	Limited reach and lifespan of AI pilots	Align AI use with institutional digital transformation plans
Inclusion & Equity	Uneven access or literacy gaps	Ensure multilingual, low-bandwidth, and user-friendly solutions

V. Conclusion

The study sought to understand how artificial intelligence would improve longevity in the context of the observed cognitive overload, explicitly focusing on master's students in mathematics at the Catholic University of Ghana and shedding light on the dual aspect of AI tools, serving as cognitive aids, reducing mental overload, facilitating learning, and as emotional buffers against academic stress. Findings established that many students have experiences of cognitive overload at moderate to high levels and were heavily relying on AI tools to cope with the heavier academic workload. The quantitative measure indicated that AI use has a statistically significant inverse relationship with stress, and qualitative interviews captured the more nuanced experiences, ranging from empowerment to moral dilemmas. The study developed a framework integrating cognitive load theory, allostatic load theory, and socio-technical systems theory to explain how technology can underpin academic performance and sustain cognitive and emotional health over the long run. As education systems forge a path in the post-pandemic era of digitalization, this research points out that human-centered AI design amid ethical considerations and pedagogical innovations holds an opportunity for transformation toward improved academic achievement and mental well-being. Future work should explore intervention approaches across disciplines, diverse age groups, and evolving definitions of cognitive longevity in increasingly digitalized learning ecosystems. Based on the study's findings, theoretical integration, and practical implications, the following recommendations are proposed at short-, medium-, and long-term levels to guide institutions, policymakers, and researchers in leveraging AI to support cognitive well-being and academic longevity:

a. Short-Term Recommendations (0–6 Months)
   - Develop and Integrate AI Literacy Programs: Implement training modules or workshops on effectively and ethically using AI tools in academic research, particularly for STEM-focused graduate programs.
     Responsible units: Academic Affairs, ICT Unit
   - Formalize Access to Approved AI Tools: Provide vetted access to AI platforms like ChatGPT, Grammarly EDU, and WolframAlpha through institutional logins or learning platforms. Responsible units: Library Services, Department Heads
   - Raise Awareness on Cognitive Load and AI Support: Host public lectures or awareness campaigns to sensitize students and faculty about cognitive overload and AI's role in managing academic pressure.

b. Medium-Term Recommendations (6–18 Months)

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- Embed AI-Ethics in Curricula: Design AI-focused ethics courses tailored to graduate students, addressing concerns about overreliance, authorship, and originality. Collaborating departments: Philosophy, Computer Science, Educational Psychology
- Create a University Policy on AI Use in Academia: Draft guidelines that define acceptable use of AI tools in coursework, thesis writing, and examinations to ensure consistency and fairness.
- Train Faculty in Pedagogical Integration of AI: Equip lecturers with skills to incorporate AI into instructional methods without compromising critical thinking development.

c. Long-Term Recommendations (2+ Years)

- Establish AI-Supported Cognitive Well-being Units: Institutionalize AI-augmented wellness services that offer academic time management tools, AI journaling for stress relief, and virtual mentorship via AI platforms.
- Conduct Longitudinal Studies on AI and Cognitive Load: Encourage faculty and postgraduate research into the evolving impact of AI on learning, attention, and student performance over time.
- Develop Interdisciplinary AI and Education Research Hubs: Position the Catholic University of Ghana as a regional leader in AI-in-Education research by fostering partnerships across disciplines.

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