



Cognitive load, AI literacy, and doctoral students' academic procrastination: Conceptual review

Annisa Ciptagustia¹, Eeng Ahman², Edi Suryadi³, Rofi Rofaida⁴, Murni Zarina Mohamed Razali⁵

^{1,2,3,4}Universitas Pendidikan Indonesia, Kota Bandung, Indonesia

⁵Universiti Teknologi Mara, Selangor, Malaysia

annisacipta@upi.edu¹, eengahman@upi.edu², edi_suryadi@upi.edu³, rofi.rofaida@upi.edu⁴,
murnizarina@uitm.edu.my⁵

ABSTRACT

Research on doctoral students is still fragmented in the study of Cognitive Load Theory (CLT), academic procrastination, and Artificial Intelligence (AI) literacy. This article integrates these three fields to explain the interaction between cognitive load, AI literacy competency, and academic procrastination in the context of doctoral students with dual roles in the era of generative AI. Using an integrative conceptual paper approach and a systematic search in the Scopus database (254 final articles: 58 CLT, 56 procrastination, 140 AI literacy), we found that none of the three streams connected all three constructs simultaneously. Five integrative propositions were formulated, namely (P1) cognitive load as a causal antecedent of procrastination; (P2) AI literacy as a moderator of the CLT-procrastination relationship; (P3) Self-Regulated Learning (SRL) and self-efficacy as dual mediators; (P4) dual-role as a cognitive load amplifier; and (P5) intellectual procrastination or the paradox of AI competence without adequate SRL. This article contributes to postgraduate curriculum design by offering five curricular components that are based directly on the identified causal mechanisms.

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ABSTRAK

Penelitian tentang mahasiswa doktoral masih terfragmentasi dalam kajian Cognitive Load Theory (CLT), prokrastinasi akademik, dan literasi Artificial Intelligence (AI). Artikel ini mengintegrasikan ketiga bidang tersebut untuk menjelaskan interaksi antara beban kognitif, kompetensi literasi AI, dan prokrastinasi akademik dalam konteks mahasiswa doktoral dengan peran ganda di era AI generatif. Melalui pendekatan integrative conceptual paper dengan systematic search di database Scopus (254 artikel final: 58 CLT, 56 prokrastinasi, 140 AI literacy), ditemukan bahwa tidak ada satu pun dari ketiga stream yang menghubungkan ketiga konstruk secara bersamaan. Lima proposisi integratif dirumuskan, yaitu (P1) cognitive load sebagai anteseden kausal prokrastinasi; (P2) AI literacy sebagai moderator hubungan CLT-prokrastinasi; (P3) Self-Regulated Learning (SRL) dan self-efficacy sebagai mediator ganda; (P4) dual-role sebagai amplifier beban kognitif; dan (P5) prokrastinasi intelektual atau paradoks kompetensi AI tanpa SRL yang memadai. Artikel ini berkontribusi pada desain kurikulum pascasarjana dengan menawarkan lima komponen kurikuler yang didasarkan langsung pada mekanisme kausal yang telah teridentifikasi.

Kata Kunci: literasi AI; mahasiswa doktoral; prokrastinasi akademik; teori beban kognitif

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INTRODUCTION

Doctoral students are currently navigating the complexities of demanding research, dual professional-academic roles, and, since 2022, the unresolved ambiguities posed by generative Artificial Intelligence (AI), collectively constituting a triadic cognitive burden that is not adequately explained by motivational frameworks alone. However, despite the growing body of research across Cognitive Load Theory (CLT), academic delay, and AI literacy, these streams have thrived in disciplinary isolation: no one has simultaneously examined how cognitive architecture, AI competencies, and procrastination behaviors interact as integrated systems at the doctoral level. Whether this delay in the population reflects a motivational failure or a structural response to cognitive overload remains an open theoretical question, which has surprisingly received little systematic attention in the higher education literature.

This phenomenon can be understood through three streams of literature that have developed relatively independently. First, CLT has made a significant contribution to the development of learning designs and cognitive load measurement instruments, particularly in undergraduate education. Although meaningful progress has been made in operationalizing three types of cognitive load through the MCLS-POL, their validation relied on structured, experimentally controlled settings that differ substantially from the open-ended demands of doctoral academic work (Andersen & Makransky, 2021). More critically, existing CLT research has not examined how sustained cognitive overload translates into maladaptive behavioral outcomes, most notably, procrastination as a form of self-regulatory breakdown.

Second, the literature on academic procrastination has extensively examined its prevalence and determinants, including at the doctoral level. For example, procrastination has been identified as a common challenge faced by many PhD students throughout their doctoral journey, While the role of self-efficacy and Self-Regulated Learning (SRL) as important mediators has been emphasized in the literature, this body of work remains largely anchored in psychological and motivational explanations, leaving the underlying cognitive mechanisms particularly how cognitive load shapes procrastinatory behavior undertheorized and empirically underdeveloped (Santos-Jaén et al., 2025). Third, research on AI literacy indicates that the capacity to evaluate critically and adaptively use AI-based tools is associated with improved self-regulation and reduced academic stress, operating through metacognitive and reflective processes rather than technical proficiency alone.

AI literacy can serve a protective function under conditions of academic stress, acting as a moderator between work demands and burnout (Yin et al., 2025). Nevertheless, these findings are largely drawn from structured instructional contexts, leaving it unclear how AI literacy operates under the chronic cognitive demands of doctoral-level research. However, the link between AI literacy and procrastination behavior, particularly in the context of doctoral education, remains relatively limited and has not been integrated into cognitive frameworks such as CLT. A critical examination of the existing literature reveals a consistent pattern of disciplinary isolation: CLT scholarship has not treated procrastination as a dependent variable, procrastination research has not drawn on CLT as a theoretical framework, and AI literacy studies have not examined the implications of AI literacy for academic procrastination, particularly at the doctoral level.

These three gaps, taken together, suggest that existing literature has addressed cognitive load, procrastination, and AI literacy as separate phenomena, leaving underexplored the ways in which they may interact to shape doctoral research productivity in the context of generative AI. The novelty of this article lies in a shift in perspective on academic procrastination at the doctoral level, integrating CLT and AI literacy into a single mechanism-based framework. Instead of viewing procrastination solely as a motivational problem, this study places it within the context of the cognitive load configuration in complex, self-directed research activities. This article also expands the role of CLT from learning design to advanced research behavior analysis. This paper introduces the concept of the *AI Competence Paradox* as a new theoretical lens for understanding academic productivity in the era of generative AI.

Based on the identified gaps, this article addresses the following overarching research question: How do cognitive load, AI literacy, and academic procrastination interact as doctoral students navigate dual professional-academic roles in the era of generative AI? More specifically, this study asks: 1) What role does cognitive load play in shaping procrastination behavior among doctoral students?; 2) How does AI literacy relate to the cognitive and self-regulatory processes underlying procrastination?; 3) Under what conditions do contextual demands, including dual role pressures and generative AI ambiguities, intensify cognitive burden and undermine academic productivity in this population?. This article aims to fill this gap through an integrative conceptual approach by: 1) Mapping convergent gaps across three literature streams, CLT, academic procrastination, and AI literacy; 2) Constructing an integrative theoretical model of their causal interrelationships in the doctoral context; and 3) Formulating empirically testable propositions and deriving implications for postgraduate curriculum design.

LITERATURE REVIEW

Cognitive Load Theory (CLT): Theoretical Foundations and Doctoral Context

Doctoral students face academic demands that are qualitatively different from those of undergraduate students. In addition to managing the complexity of high-level research, they often take on the dual role of active professionals, teachers, or even parents. Amid these demands, the era of generative Artificial Intelligence (AI) is introducing a new dimension: uncertainty about how, when, and to what extent AI tools can be used ethically in the research and dissertation-writing process. The layered cognitive burden arising from research complexity, role conflicts, and AI policy ambiguity may constitute a contributing condition under which academic procrastination emerges as a structural response to a relationship that warrants empirical examination in future research.

Academic procrastination among doctoral students is not just a matter of motivation but a phenomenon that stems from a typical configuration of cognitive load and remains underexplored in the higher education literature. A synthesis of 58 CLT studies published between 2020 and 2026 helps explain why excessive cognitive load may lead to procrastination rather than other psychological outcomes, such as anxiety or burnout. The distinction lies in the timing and nature of these responses. Anxiety and burnout typically emerge as cumulative affective reactions that develop during sustained task engagement,

whereas procrastination represents an avoidance-oriented self-regulatory response that occurs before task initiation (Steel, 2007).

Consequently, procrastination is particularly likely to arise in self-directed doctoral work, where external scheduling structures and automated task segmentation are often absent (Gross & Hansen, 2024). The weakening of emotion regulation resulting from excessive cognitive load has been shown to precede, rather than follow, the emergence of procrastination (Hu et al., 2025; Zhang et al., 2026). This finding suggests that CLT can serve as a predictive mechanism identifying task conditions under which procrastination becomes a structurally probable outcome rather than merely a descriptive framework. Accordingly, CLT constitutes the first theoretical foundation of the proposed integrative model.

Academic Procrastination in Doctoral Students: Mechanisms and Determinants

Academic procrastination is commonly defined as the voluntary delay of an intended course of action despite expecting negative consequences, making it a quintessential form of self-regulatory failure (Steel, 2007). Among doctoral students, procrastination has become particularly prevalent, with reported rates ranging from 70% to 95% (Santos et al., 2025). Five reasons for doctoral students' procrastination have been identified, each of which corresponds directly to a cognitive load type: publication pressure and thesis complexity increase intrinsic load, supervisor conflict and impostor syndrome produce extraneous load, while fear of failure drains the germane load, thereby forming an initial bridge between the two literatures (Gross & Hansen, 2024).

The literature further suggests that SRL and academic self-efficacy are among the most influential mechanisms linking cognitive and behavioral outcomes. SRL has been shown to alter the functional relationship between stress perception and behavioral delay (Ma et al., 2022). Similarly, self-efficacy fully mediated the association between motivational factors and procrastination among 522 PhD students (Santos et al., 2025). These findings suggest that self-efficacy and SRL may function as sequential mechanisms by which cognitive and psychological conditions shape procrastination tendencies. Additional evidence indicates that contextual demands also play an important role. Managing multiple roles simultaneously does not merely increase cognitive burden but may also alter the way individuals regulate their cognitive resources and academic behavior (Lima & Dourado, 2025).

Such findings are particularly relevant for doctoral students, who frequently balance academic responsibilities with professional and family commitments. Procrastination research has consistently examined who procrastinates and highlighted self-efficacy, SRL, and supervisor support (Ma et al., 2022; Meng et al., 2025; Santos et al., 2025; Trisnawati & Rahimi, 2022; Yang et al., 2025). The question that has never been asked is what kind of cognitive condition makes procrastination difficult to avoid. Cognitive load has been shown to weaken SRL, and weakened SRL contributes to procrastination; however, these three constructs have not yet been tested together within a single integrated model (Ma et al., 2022). This study addresses these gaps by examining cognitive load, SRL, and doctoral academic procrastination as a series of systems that shift the perspective to the idea that

procrastination can be overcome not only on the individual level but also in how the cognitive demands of academic tasks themselves are designed.

AI Literacy as a Cognitive Load Regulator, Theoretical Mechanisms and Empirical Evidence

AI literacy is conceptualized as a multidimensional competency encompassing technical, applicative, evaluative, and ethical dimensions that vary across educational levels and disciplinary contexts (Chee et al., 2025). Within the framework of CLT, it operates through two paths: the selective delegation of extraneous loads to AI tools to free up working memory for tasks of high germane value, and cognitive scaffolding that externalizes part of the ideation process without eliminating active intellectual involvement. Using structural equation modeling on a sample of 1,056 university students, SRL was found to fully mediate the relationship between AI literacy and psychological need satisfaction (Wang et al., 2025). Similarly, SRL was found to mediate the relationship between AI literacy and writing performance (Shi et al., 2025).

Extending this line of research, AI self-efficacy has been identified as a linking mechanism between attitudes toward AI and autonomous academic functioning, suggesting a sequential pathway in which AI literacy enhances AI self-efficacy, which in turn strengthens SRL, increases academic self-efficacy, and ultimately reduces procrastination (Bewersdorff et al., 2025). However, among the 140 AI literacy articles studied, none explicitly tested this sequence in a single integrated model despite the relevant partial overlap. AI literacy has been linked to SRL strategies and writing performance, while overreliance on AI has been associated with skill decline and decreased intrinsic motivation (Alhur et al., 2025; Shi et al., 2025; Wang et al., 2025).

These patterns suggest that AI literacy is more appropriately positioned as a moderator variable rather than a direct antecedent of procrastination. First, its role appears most significant under high cognitive stress and less relevant when task demands are low, which conceptually distinguishes the moderator from the antecedent (Cheung et al., 2025). Second, empirical evidence suggests that over-reliance on AI can paradoxically increase procrastination and weaken academic performance (Abbas et al., 2024). Moreover, the flexibility of AI platforms in the absence of structured schedules may contribute to task delays, suggesting a conditional rather than a purely linear relationship between AI use and procrastination (Zhang et al., 2024). Third, the protective function of AI literacy is stronger under high-pressure conditions, further supporting its contingent rather than direct effects on academic behavior (Yin et al., 2025).

Proposed Conceptual Model

Based on the convergence of the reviewed literature, SRL and academic self-efficacy emerge as sequential mediators between cognitive load and procrastination, grounded in three theoretical premises. First, cognitive overload reduces executive regulation capacity for task initiation, and in the context of self-directed doctoral work, this decline is associated with procrastination (Ma et al., 2022). Second, SRL is the primary protective mechanism that determines whether cognitive load leads to procrastination, independent of motivational or

personality factors (Shi et al., 2025; Wang et al., 2025). Third, AI literacy can only activate load delegation capacity when students possess adequate SRL to manage AI strategically (Bewersdorff et al., 2025). SRL therefore functions as the first mediator, transforming AI literacy capacity into real cognitive regulation. In contrast, self-efficacy serves as the second mediator, as SRL alone is insufficient to initiate tasks perceived as threatening or cognitively demanding (Liu et al., 2020). The convergence of these three premises suggests that SRL and self-efficacy constitute theoretically grounded mediators within the proposed causal pathway.

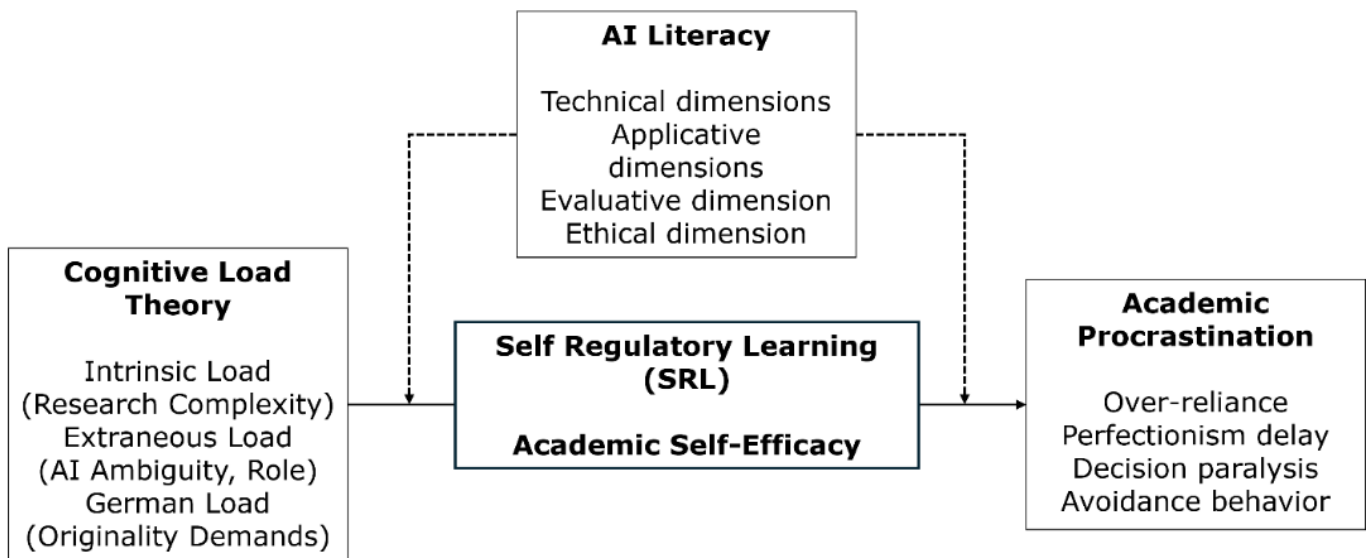


Figure 1. CLT, AI Literacy, and Academic Procrastination Integrative Model in Doctoral Students
Source: Author Data Processing, 2026

Figure 1 presents a four-layer model comprising cognitive load as the antecedent, AI literacy as the moderator, SRL and self-efficacy as sequential mediators, and academic procrastination as the outcome, with each pathway supported by at least two independent empirical sources. The model is distinguished by three characteristics that have not been simultaneously addressed in prior research. First, AI literacy is conceptualized not merely as a strengthening or weakening variable, but as one that reshapes how students process and organize cognitive load itself (Sharma & Khadka, 2026). Second, the model accommodates the empirically observed paradox whereby students with high AI literacy may still procrastinate under conditions of extreme cognitive demand (Abbas et al., 2024; Alhur et al., 2025). Third, the model is situated specifically within the context of intensive and independent dissertation writing, a context consistently identified as uniquely procrastination-prone yet theoretically underspecified (Cornejo-Araya et al., 2024; Gross & Hansen, 2024). Together, these characteristics position the proposed model as an empirically testable causal structure that extends beyond existing frameworks by integrating cognitive load, AI literacy moderation, and sequential SRL-self-efficacy mediation within a unified system.

METHODS

This study adopts an integrative conceptual paper approach to develop a novel theoretical framework by synthesizing existing literature, identifying conceptual gaps, and formulating testable propositions (Jaakkola, 2020; Torraco, 2016). Unlike traditional literature reviews that primarily summarize previous findings, the integrative conceptual approach seeks to generate new theoretical insights by connecting previously fragmented streams of research into a coherent explanatory framework. The study focuses on integrating three major research domains: CLT, academic procrastination, and AI literacy in higher education. A systematic search was conducted using the Scopus database to ensure a comprehensive and contemporary evidence base.

Three independent search streams were employed: “cognitive load theory” AND (“higher education” OR “postgraduate” OR “doctoral”); “academic procrastination” AND (“doctoral student” OR “postgraduate” OR “graduate student”); and (3) (“AI literacy” OR “artificial intelligence literacy”) AND “higher education”. The search was restricted to Article Title, Abstract, and Keywords and limited to publications from 2020 to April 2026 to capture the most recent developments in higher education research, particularly those emerging after the rapid advancement of generative artificial intelligence technologies. Studies were included if they were published in peer-reviewed, Scopus-indexed journals, written in English, focused on higher education contexts, available in full text, and substantively addressed at least one of the focal constructs. Studies were excluded if they consisted primarily of opinion-based articles without a clear theoretical foundation, conference proceedings lacking rigorous peer review, or duplicate records identified during screening.



Figure 2. Article Selection Flow Based on the PRISMA Protocol (Adapted)
Source: Author Data Processing, 2026

The article selection process consisted of four stages: identification, title and abstract screening, full-text assessment, and final inclusion. **Figure 2** presents the complete screening procedure used in this study. The initial search yielded 1,722 records. Following the removal of duplicate and irrelevant studies through successive screening stages, 254 articles were retained for the final analysis, comprising 58 studies on CLT, 56 on academic procrastination, and 140 on AI literacy. The selected studies were analyzed using a theory synthesis strategy. The analysis focused on identifying recurring constructs, theoretical relationships, mediating and moderating mechanisms, and unresolved conceptual tensions across the three literature streams. The resulting synthesis served as the foundation for developing an integrative framework explaining how cognitive load influences academic procrastination through SRL and academic self-efficacy. At the same time, AI literacy functions as a contextual moderating resource.

RESULTS AND DISCUSSION

The analysis across three literature streams identified six convergent gaps, each appearing independently across all three domains, a pattern suggesting that cognitive load, academic procrastination, and AI literacy have developed in disciplinary isolation despite their theoretical interdependence. **Table 1** presents the full convergent gap matrix.

Table 1. Convergent Gap Matrix of Three Streams of Literature

No	Dimension Gap	Gap from CLT	Gap from Procrastination Literature	Gap from AI Literacy
G-1	Procrastination as a dependent variable in the cognitive framework	CLT is never directed to procrastination behavior; only on instructional design and learning outcomes (0/58 articles)	Procrastination is studied without a cognitive framework; "overload" is mentioned but not operationalized (Annisaq et al., 2025; Herut & Gorfu, 2024)	AI literacy is linked to motivation & SRL, but not to procrastination as avoidance behavior (0/140 articles)
G-2	AI literacy as a moderator of cognitive load	AI is positioned as an extraneous load reduction tool (Sharma & Khadka, 2026), not as an individual competence that moderates.	The ambiguity of the use of AI in research is mentioned as a new source of stress, but is not conceptualized cognitively (Cheng et al., 2025)	AI literacy has been shown to moderate work stress in burnout, but procrastination has not been included as an outcome.
G-3	Dual-role doctoral as a CLT configuration amplifier	CLT in higher education is dominant for single-role learners; the extraneous load of	Dual-role has been shown to increase procrastination in mothers pursuing higher education,	AI literacy for dual-role academics has not been researched; Mai et al. (2025) examined AI

No	Dimension Gap	Gap from CLT	Gap from Procrastination Literature	Gap from AI Literacy
		non-academic roles has not been researched in a doctoral context	whose psychological capital mediates procrastination outcomes (Fadhil et al., 2025; Lima & Dourado, 2025; Walter & Hazan-Liran, 2025), but the cognitive mechanism has not been explained	proficiency in lecturers (non-dual-role doctoral)
G-4	Intention-behavior gap in the context of AI and procrastination	CLT explains cognitive depletion, but it has not been linked to the gap between productive intentions and actual procrastination behavior.	The gap between learning motivation and actual procrastination appears, but is not cognitively explained	High AI literacy predicts intent (Yang et al., 2025), $\beta=0.408$, but found low adoption despite high acceptance ($R^2=0.01$)
G-5	Longitudinal studies and the Indonesian/ASEAN context	Almost all CLT studies are cross-sectional; there are no longitudinal studies of CLT for doctoral procrastination. Indonesia is not represented.	Only Rahimi et al. (2023) is longitudinal, of 35 doctoral articles; Indonesia: only Fadhil et al. (2025) and Annisaq et al. (2025).	The majority of AI literacy studies are cross-sectional; the Indonesian/ASEAN context is almost non-existent (Syukur et al., 2025).
G-6	CLT measurements specific to AI contexts and dissertation writing	The MCLS-POL instrument is valid for public lectures, but has not yet been adapted for research writing contexts involving AI	Procrastination is measured with generic instruments; a doctoral-specific instrument is available but not yet integrated with CLT	AI literacy is measured with a variety of non-standard instruments; GLAT (Jin et al., 2025) has just been developed, but has not yet been integrated with CLT

Source: Authors' synthesis of selected Scopus articles, 2026

The most critical finding was G-1: of the 254 articles analyzed, none simultaneously linked CLT, AI literacy, and doctoral procrastination. Even in the paired analysis, only one article explicitly used cognitive perspectives in procrastination studies (CLT on Procrastination), while providing the closest precedent for the relationship between AI Literacy in CLT and work stress. This triadic void, in which none of the CLT studies on Procrastination in AI literacy prove the fundamental novelty of the framework that this article builds on. The following five propositions constitute a convergent synthesis of the three streams of literature. Each

proposition: 1) is supported by empirical evidence from at least two different streams; 2) is written in an empirically testable format; and 3) lists boundary conditions that limit the generalization. From these results, five propositions were obtained that form a single interrelated theoretical framework, although most of the relationships among them remain propositional and require further empirical confirmation. The five propositions are:

Proposition 1 is that doctoral students face three layers of cognitive burden simultaneously: the complexity of the research itself, the ambiguity of AI's role and technology, and the pressure to produce original work. When these three layers exceed the available working memory capacity, procrastination is thought to arise not only as a character weakness but as a response to an overloaded cognitive system (Geberkidan et al., 2025). This effect is predicted to be stronger among students with dual roles and at the dissertation-writing stage, although empirical testing across study stages remains limited.

Proposition 2 proposes AI literacy that includes technical, applicative, evaluative, and ethical abilities as a moderator that potentially weakens the relationship between cognitive load and procrastination, assuming that AI-literate individuals can selectively delegate extraneous load components, thereby freeing up working memory capacity (Alam et al., 2026; Marie-Amélie & Shankland, 2023; Taghavi-Nejad et al., 2024). However, this moderation is not assumed to be linear: at very high levels of AI literacy without adequate SRL, the model anticipates the possibility of the opposite effect, namely dependency-based procrastination, for a hypothesis that needs to be empirically tested.

Proposition 3 explains that the effects of AI literacy on procrastination are likely not direct but rather sequentially mediated: AI literacy first activates SRL strategies, which then build academic self-efficacy, which then contributes to a decrease in procrastination. This mediation chain is still theoretical and has not been fully tested in the context of the doctoral link. Each link is supported by different literature, but simultaneous model testing has not been conducted.

Proposition 4 deepens this argument by asserting that the dual-role condition of serving as a researcher as well as a professional, teacher, or parent is likely to change the cognitive configuration qualitatively, rather than add to the burden quantitatively. The procrastination patterns that emerge are also suspected to differ: perfectionism-driven delay, overload avoidance, and decision paralysis (Huang & Zhao, 2025). This qualitative difference is practically relevant because it implies that interventions designed for undergraduate students may not be directly applicable to doctoral contexts.

Proposition 5 discusses the intuitively opposite possibility: increasing AI literacy without adequate SRL reinforcement has the potential to give rise to new forms of procrastination, such as being stuck perfecting prompts instead of starting to write, over-reliant on AI for tasks that are supposed to build self-sufficient capacity, or experiencing confusion among too many tool choices (Koć-Januchta et al., 2022; Patria & Laili, 2021; Yin, 2025; Yusof et al., 2025). An early indication of this complexity is reflected in the finding that AI acceptance explained only 1% of the variance in actual research productivity ($R^2 = 0.01$) (Owan et al., 2025). This finding suggests that positive attitudes toward AI alone may be insufficient to improve academic outcomes, implying that the effectiveness of AI-related competencies may depend on contextual factors such as cognitive demands, self-regulation, and learning conditions. Overall, these five propositions argue that addressing doctoral procrastination in

the AI era will likely require simultaneous interventions: managing cognitive load, building targeted AI literacy, and strengthening SRL. However, since all these relationships are still propositional, empirical testing of the ideal longitudinal design in the doctoral population is a necessary step before practical implications can be drawn more convincingly.

Discussion

Theoretical Implications

The integrative framework on which this article builds makes significant theoretical contributions. First, this article expands the domain of CLT applications from instructional design to self-regulatory behavior, specifically procrastination (Sweller et al., 2019). This step addresses criticism that CLT is too narrow in its application and needs to be extended to encompass a broader self-regulatory phenomenon. By reconceptualizing procrastination as a manifestation of cognitive overload rather than merely a motivational failure, this article offers a practical consequence: doctoral procrastination is not a 'character problem' but a 'systems design problem' that can be addressed through structural intervention. Second, the placement of AI literacy as a moderator in the CLT model makes a new contribution to the AI literacy literature, which has been framed more as an outcome (how high is students' AI competence?) than as a regulatory process.

The integration with CLT shifts the question of 'how high is student AI literacy' to 'how AI literacy changes the way students manage cognitive load', a shift that opens a new research agenda. Third, the paradoxical concept of competence (5th proposition) makes the most theoretically original contribution. Previous literature has often assumed that higher AI literacy always leads to better outcomes. This proposition challenges these assumptions with empirically supported arguments, as evidence suggests that high levels of AI literacy without adequate SRL may create new procrastination patterns that differ qualitatively from conventional procrastination (Owan et al., 2025).

Comparison with Existing Frameworks

The proposed integrative model has structural similarities to some existing frameworks but differs in key aspects. Compared with the Temporal Motivation Theory, which explains procrastination through value and expectancy calculations, the CLT-centric model proposed here emphasizes cognitive mechanisms (working memory capacity) as determinants of procrastination rather than motivational calculations. Both frameworks are complementary: TMT explains why students procrastinate, while CLT models explain how cognitive systems make procrastination an 'easy' response to perform.

Compared to Self-Determination Theory, which underpins many studies on academic procrastination, the proposed model focuses on cognitive and competency-based mechanisms rather than the fulfillment of psychological needs. Nevertheless, both perspectives converge on the central role of SRL. SRL has been shown to mediate the relationship between supervisor support and procrastination, while the present model positions SRL as a mediator between AI literacy and procrastination (Wang & Wang, 2024).

Implications for Curriculum Development

The five propositions carry direct implications for doctoral curriculum design. P1 and P4 suggest that the curriculum should be structured not only around content objectives but around the cognitive conditions that make learning possible, shifting the design question from "what to learn" to "under what cognitive conditions students can learn effectively." P2 and P3 further indicate that competencies are not additive but conditional and sequential: AI literacy is effective only when preceded by adequate SRL, and SRL is productive only when academic self-efficacy is strong enough to translate cognitive capacity into real action. On a practical level, five interconnected changes are warranted. First, AI literacy courses should be explicitly designed using CLT principles, segmented content, gradual scaffolding from technical to ethical dimensions, and reflective tasks that build germane load, enabling students to distinguish AI-delegable tasks from those requiring independent cognitive engagement (Fadli, 2025; Öner, 2025).

Second, SRL should be embedded as a cross-curricular competency across all research sessions through structured goal setting, dissertation progress monitoring, and regular AI-use reflection, rather than treated as a standalone course. Without systematic SRL strengthening, increasing AI literacy risks producing the competence paradox formulated in Proposition 5. Third, doctoral programs should establish an institutional AI Window policy that operationally clarifies which tasks may be AI-assisted and which must be completed independently, not as a prohibition, but as a CLT-based cognitive load management structure that reduces procrastination arising from policy ambiguity (Stracke et al., 2025).

Fourth, supervisors should be trained to identify cognitive overload manifesting as procrastination. To recognize repetitive, unproductive revisions as perfectionism-delay and unresponsiveness as overload-avoidance. To respond through CLT-based task decomposition rather than additional pressure (Koneru, 2023; Meng et al., 2025). Fifth, assessment systems should shift toward process-based formats, such as chapter drafts, milestone presentations, and AI usage logs, to enable early detection of overreliance and prevent students from entering deeper procrastination cycles (Akbar, 2025). These five components are interdependent and must be implemented as an integrated system rather than selectively.

Future Research Study

Based on the identified convergent gaps, this article recommends eight priority research agendas, each designed to address at least two gaps from different streams, so that each study can make an efficient, multiple-contribution.

Table 2. Future Research Recapitulation Agenda

No	Research Agenda	Description	Gap	Method
FR-1	CLT instrument validation for an AI-based dissertation	Adaptation of MCLS-POL to separate extraneous load from AI vs. other factors in the context of dissertation writing.	G-1, G-6	CFA, IRT; cognitive interview; pilot n=50-100

No	Research Agenda	Description	Gap	Method
FR-2	Empirical test of the CLT model and AI Literacy and Indonesian doctoral procrastination	PLS-SEM cross-sectional: three types of CLT (IV), AI literacy (moderator), SRL + self-efficacy (mediator), procrastination (dependent variable).	G-1, G-2, G-5	PLS-SEM; n=200-400; ≥3 universities in Indonesia, both public and private
FR-3	Longitudinal study of doctoral procrastination across study stages	Panel 3 measuring points (semesters 1, 3, 5): identification of procrastination critical points and protective factors at each stage.	G-3, G-5	Longitudinal panel; mixed methods; n=80-120
FR-4	CLT-based AI literacy intervention experiment	Gradual segmentation program, extraneous load reduction, germane load reinforcement) vs. conventional control.	G-1, G-2, G-4	Quasi-experimental; pre-post-follow-up; n=60-120
FR-5	Meta-analysis: cognitive burden and procrastination in higher education	Synthesis of CLT-adjacent constructs (workload, cognitive demand, self-control) and procrastination; Estimation of Effect Size & Moderator.	G-1, G-6	Systematic review + meta-analysis; PRISMA protocol; k=30-50
FR-6	Qualitative exploration of the procrastination experience of the AI era	Phenomenon: how doctoral students experience and respond to the interaction of cognitive load, AI, and procrastination.	G-3, G-5	Phenomenological ; in-depth interview; n=15-20; thematic analysis
FR-7	Development of doctoral AI literacy profiles for procrastination management	Taxonomy of AI literacy profiles (adaptation of Medina-Gual et al., 2025) and its correlation with procrastination & CLT patterns.	G-2, G-3	Cluster analysis / multidisciplinary
FR-8	ASEAN cross-country comparison: CLT × doctoral procrastination	Compare the patterns of CLT, AI literacy, and doctoral procrastination in 4 countries	G-3, G-5	Cross-national; mixed methods; n=50-80/country

Source: Researcher, 2026

Based on the gaps identified in Table 2, this article proposes eight research agendas for future scholars to pursue. First (FR-1), researchers can adapt the MCLS-POL instrument to measure cognitive load specifically in AI-assisted dissertation writing contexts that do not yet exist. Second (FR-2), a cross-sectional study using PLS-SEM can empirically test how cognitive load, AI literacy, SRL, and self-efficacy jointly predict procrastination among Indonesian doctoral students with dual roles. Third (FR-3), a longitudinal panel study tracking the same doctoral students across three semesters can reveal when procrastination peaks and what factors protect against it. Fourth (FR-4), a quasi-experimental intervention can test whether a CLT-based AI literacy training program effectively reduces procrastination over time.

Fifth (FR-5), a systematic meta-analysis following the PRISMA protocol can consolidate existing evidence on the cognitive load-procrastination relationship and estimate its true effect size. Sixth (FR-6), a phenomenological qualitative study, can document how

Indonesian dual-role doctoral students personally experience and navigate the interplay among cognitive overload, AI use, and procrastination. Seventh (FR-7), researchers can develop a doctoral AI literacy profile taxonomy that classifies students according to their AI competence patterns and links each profile to procrastination risk (Medina-Gual et al., 2025).

Eighth (FR-8), a cross-national comparative study across ASEAN countries, can test whether the proposed model holds across different cultural and institutional contexts in the Global South. Collectively, these agendas form a tiered trajectory from instrument development (FR-1), model testing (FR-2; Lin & Chen, 2025), understanding temporal dynamics (FR-3), causal evidence of intervention (FR-4; Yang et al., 2025), meta-analytical synthesis (FR-5), lived experience documentation (FR-6), profile-based typology (FR-7), to cross-regional validation (FR-8) providing a clear empirical roadmap for moving the propositions in this article from theoretical propositions toward confirmed knowledge.

CONCLUSION

This study suggests that academic procrastination among doctoral students in the era of generative AI is better understood as a cognition-regulatory phenomenon than a purely motivational one. By synthesizing literature across three previously isolated streams, this article demonstrates that cognitive load, AI literacy, and SRL constitute an interdependent explanatory system, one that existing single-framework approaches have been unable to capture. The five propositions collectively advance a theoretical foundation for reconceptualizing doctoral procrastination and offer actionable directions for curriculum reform that is responsive to the cognitive realities of AI-mediated academic work. This study is subject to several limitations: the absence of empirical data, reliance on a single database, and the underrepresentation of Indonesia and ASEAN contexts, all of which point to productive directions for future empirical investigation.

AUTHOR'S NOTE

The author declares that there is no conflict of interest related to the publication of this article. The author emphasizes that the data and content of the article are free from plagiarism.

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