



# Cognitive navigation: A phenomenological study of prospective elementary school teachers' experiences in managing cognitive overload in blended learning

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## Abstract

The digital transformation in higher education has established blended learning as a permanent pedagogical paradigm, yet it has created a paradox in which instructional flexibility often leads to increased cognitive complexity for students. This study aims to explore the lived experiences of Elementary School Teacher Education students in navigating cognitive overload and to identify adaptive strategies employed to maintain learning effectiveness in a blended learning environment. Using a qualitative-phenomenological design, this study involved active students at *IKIP PGRI Wates* who had completed at least one semester of blended learning. Data were collected through semi-structured in-depth interviews and reflective learning journals, which were then analyzed using an inductive thematic approach. The findings reveal that cognitive overload is primarily triggered by fragmented instructional design, technical friction between platforms, and unmanaged dual task demands. These factors led to a degradation in the quality of cognitive processing, shifting students' orientation from deep conceptual understanding toward a pragmatic, administrative focus. However, these findings also highlight the crucial role of Self-Regulated Learning as a metacognitive resilience mechanism that mitigates the impacts of mental fatigue and academic stress. This study concludes that cognitive overload in blended learning is a multidimensional phenomenon that requires coherent instructional synchronization and systematic support for students' self-regulation. The practical implications of this study emphasize the need for platform standardization and the integration of metacognitive training as crucial navigational tools for prospective elementary school teachers to ensure their cognitive resilience in implementing learning technologies in the future.

## Introduction

The digital transformation in higher education has established blended learning as a permanent dominant paradigm (Mukul & Buyukozkan, 2023; Oliveira & Souza, 2022). In the Indonesian context, this transformation is accelerated by national policies and the geographical necessity for flexible access, forcing institutions such as *IKIP PGRI Wates* to rapidly adapt their pedagogical frameworks. Globally, surveys by

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the World Economic Forum and UNESCO indicate that more than 85% of higher education institutions have systematically integrated online learning elements to expand accessibility (Skulmowski & Xu, 2022). This situation fundamentally changes the academic preparation of prospective elementary school teachers, who are now required to adapt to the digital ecosystem. However, behind these massive adoption figures lies a pedagogical paradox; the flexibility offered often goes hand in hand with an increase in the complexity of the mental workload. This transition demands that students possess a high degree of self-directed learning, which, if not managed properly, can actually backfire on instructional effectiveness.

The success of blended learning depends heavily on an understanding of Cognitive Load Theory (CLT), developed by John Sweller. Theoretically, CLT posits that effective learning occurs only when the cognitive demands of a task remain within the limits of the working memory's capacity, which is strictly restricted to holding and processing information in a limited duration (Sweller, 1988). In a digital context, cognitive overload occurs when the demands of the system exceed an individual's processing threshold. Data indicates that digital distractions and poor instructional design can consume up to 40% of students' cognitive capacity just for technical navigation, leaving little room for processing essential information (Sari et al., 2023; Xu et al., 2024). This theoretical foundation suggests that unless the "extraneous load" caused by poor interface design is reduced, the "germane load" required for deep conceptual understanding cannot be achieved.

The main issue with blended learning today is not the technology itself, but rather the fragmentation of its design (Hill & Smith, 2023; Labadze et al., 2023). When there is no alignment between online materials and in-person activities, students are forced to integrate information on their own, which is exhausting (Martin et al., 2021). Quantitatively, recent research highlights that fragmented learning design contributes to a 15-20% decrease in student focus over a single semester. This creates an extraneous burden that hinders students from achieving the expected level of conceptual understanding in higher education. The effects of this excessive cognitive load extend from intellectual barriers to affective disturbances (Evans et al., 2024; Zou et al., 2025). Students often find themselves caught up in the illusion of multitasking, which actually reduces overall cognitive productivity. Uncontrolled cognitive load moderates the relationship between learning engagement and student satisfaction; high cognitive load reduces the effectiveness of behavioral engagement by up to 22% (Zidi et al., 2025). Consequently, students tend to experience mental fatigue, which, if prolonged, leads to academic burnout.

As a mitigation mechanism, self-regulated learning is the single most critical factor in student success within a blended learning ecosystem (Banihashem et al., 2025; Zidi et al., 2025). Adaptive strategies such as prioritizing tasks, selecting relevant learning resources, and utilizing metacognitive awareness have been shown to reduce cognitive load (Dignath & Veenman, 2021). Empirical data indicate that students with high SRL scores maintain their academic performance 30% more consistently than their peers with low self-regulation (Ha et al., 2023). This underscores the importance of pedagogical interventions focused on developing SRL. Despite the abundance of quantitative research on these variables, a critical literature gap remains regarding the "lived experience" of students in managing these cognitive demands, particularly within the Indonesian Teacher Education Institutions (TEIs). Most existing studies treat cognitive load as a static numerical output, overlooking the dynamic, subjective, and chronological process by which students navigate cognitive barriers (Creswell, 2018). This study aims to fill this strategic gap by exploring students' subjective narratives regarding how they perceive, interpret, and ultimately overcome cognitive barriers in their daily blended learning experiences. This qualitative approach offers a depth of perspective that cannot be captured by numbers alone.

This study aims to provide an empirical foundation for educators and policymakers in designing more cognitively sustainable learning environments. By addressing this gap, the study contributes a new phenomenological framework to the literature, bridging the theoretical principles of CLT with the practical pedagogical realities in Indonesia. Through understanding students' adaptive strategies, institutions such as *IKIP PGRI Wates* can formulate instructional design guidelines that are more harmonious and focused on cognitive efficiency, particularly within the PGSD program. The results of this study are expected not only

to contribute to the theory of digital education but also to provide practical solutions for improving the quality of elementary school teacher graduates through innovative and ethical transformations of learning media in the era of Generative AI.

## Methods

This study employs a qualitative-phenomenological design to explore in depth the essence of students' experiences in navigating cognitive overload during the transition to blended learning (Creswell, 2018). The phenomenological approach was specifically chosen to uncover the "universal essence" of the phenomenon by reducing individual experiences to a description of the universal shared experience. This design allows the researcher to move beyond superficial reporting of stress toward a deeper understanding of the structural and invariant features of cognitive fatigue as perceived by the participants. The research was conducted through a systematic three-phase procedural framework. First, the "epoche" or bracketing phase was implemented, where researchers consciously set aside preconceived notions and personal biases regarding digital learning to ensure the purity of participant narratives. Second, the phenomenological reduction phase involved transforming raw data into clusters of meaning. Third, structural synthesis was performed to integrate these meanings into a comprehensive description of the "what" and "how" of the cognitive overload experience.

The research subjects were specifically focused on students in the Elementary School Teacher Education Program (PGSD), given their strategic role as future educators who must master digital instructional efficiency. The research procedures were arranged chronologically, beginning with the development of research instruments based on cognitive process dimensions, participant selection through purposive sampling, and culminating in the longitudinal acquisition of field data. The research participants consisted of active students who had completed at least one semester of blended learning; the final number of subjects was determined based on the principle of data saturation to ensure depth of information. Primary data were obtained through the integration of semi-structured in-depth interviews and reflective learning journals to record the dynamics of thinking processes, technical barriers, and students' affective responses to complex instructional demands.

All collected data were processed using a thematic analysis algorithm with an inductive approach, progressing through the stages of data familiarization, initial coding, and mapping of themes related to students' adaptive strategies (Braun et al., 2019). The analysis focused on specific measured indicators, including the frequency of technical friction, levels of mental exhaustion, and the variety of self-regulation tactics employed by students. Data validity (trustworthiness) was ensured through methodological triangulation and member checking to guarantee consistency in the researcher's interpretation of both structural and technical sources of cognitive load (Nowell et al., 2017). Additionally, research ethics were ensured through the provision of informed consent and the guarantee of participant anonymity in accordance with international research protocol standards (World Medical Association, 2015). To provide a comprehensive overview of the research workflow, a summary of the functionalities and measured indicators of each applied methodological aspect is presented in Table 1.

**Table 1.** Summary of Research Methodology

<b>Methodological Aspects</b>	<b>Functions and Operational Description</b>	<b>Measured Indicators</b>
Phenomenological Design	Exploring students' subjective experiences regarding cognitive demands and mental fatigue within a blended learning ecosystem.	Internal perceptions of mental effort and psychological barriers in blended settings.

Methodological Aspects	Functions and Operational Description	Measured Indicators
Purposive Sampling	Selecting participants with relevant experience in navigating fragmented blended learning designs.	Duration of exposure to blended learning and level of engagement with digital platforms.
Narrative Data Collection	Using in-depth interviews and reflective journals to capture metacognitive responses and self-regulation strategies.	Frequency of 'split-attention' incidents and specific affective responses (e.g., frustration, fatigue).
Inductive Thematic Analysis	Identifying core themes related to sources of stress, impacts on the learning process, and students' adaptive coping mechanisms.	Emergent patterns of information filtering, task prioritization, and resource management.
Data Triangulation	Ensuring the validity of findings through cross-source data comparison to minimize researcher subjectivity bias.	Consistency between verbal interview statements and written daily reflective journal entries.
Research Ethics Protocol	Ensuring confidentiality of identity, anonymity through coding, and voluntary participation based on informed consent.	Adherence to informed consent signatures and data de-identification (anonymity coding).

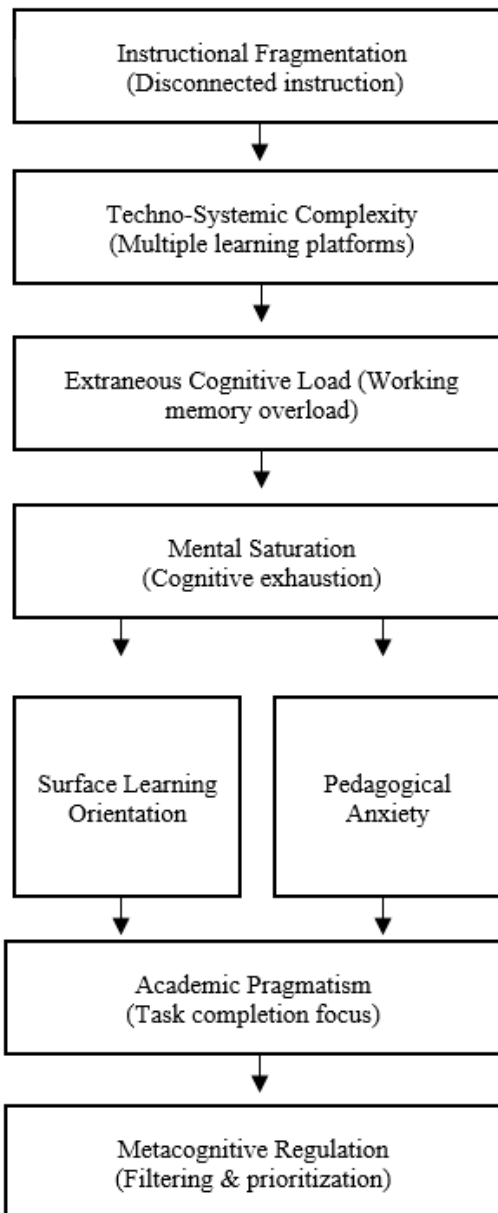
By integrating the various methodological approaches described above, this study ensures that all data collected accurately and scientifically represent the reality of students' cognitive experiences.

## Results

The data analysis followed a systematic coding procedure: initially, raw data were labeled with open codes (e.g., "manual integration," "platform switching," "task completion focus"), which were then grouped into axial codes to establish relationships between categories. Finally, selective coding was conducted to derive the four main pillars of the phenomenon. A summary of these findings is presented systematically in Table 2.

**Table 2.** Phenomenological Matrix of Cognitive Navigation and Adaptive Strategies

Dimensions of Findings	Analysis Categories	Articulation of Students' Subjective Experiences
Sources of Overload	Instructional Fragmentation	Discontinuity in pedagogical narratives between online and in-person sessions, leading to the burden of self-directed integration.
Cognitive Impact	Techno-Systemic Complexity	Navigation fatigue resulting from the use of non-integrated platforms (multi-platform friction).
	Erosion of Cognitive Depth Shift in Orientation	Dominance of surface processing due to working memory limitations. A shift in learning values from conceptual understanding to administrative pragmatism.
Affective Dimensions	Mental Fatigue	Accumulated psychological fatigue leading to reduced learning resilience.
	Pedagogical Anxiety	Students' anxiety regarding their ability to transfer knowledge to elementary school students in the future if their current learning process is distorted.
Resilience Mechanisms	Metacognitive Regulation	Implementation of "information filtering" strategies and independent task prioritization.



**Figure 1.** Phenomenological Structure of Cognitive Overload in Blended Learning

Figure 1 illustrates the phenomenological structure of cognitive overload experienced by students in blended learning environments. The phenomenon begins with fragmented instructional designs and techno-systemic complexity, which generate excessive extraneous cognitive load. Students are required to independently integrate disconnected instructional information while simultaneously navigating multiple learning platforms. This condition gradually produces mental saturation, reduces cognitive depth, and shifts learning orientation toward administrative pragmatism. Despite these pressures, students demonstrate adaptive resilience through metacognitive regulation strategies such as information filtering and task prioritization.

## The Anatomy of Extraneous Cognitive Load: Design Fragmentation and System Complexity

Research findings consistently show that the primary source of cognitive overload lies not in the difficulty level of academic material, but in fragmented instructional design. Students experience what is known as the “burden of self-integration,” in which they must synchronize different instructions across digital platforms and in-person sessions without coherent guidance. Rather than focusing their cognitive resources on understanding concepts, students are required to allocate substantial mental effort toward interpreting disconnected instructions, identifying submission procedures, and reconstructing fragmented learning sequences independently. This condition gradually transforms the learning process into a cognitively demanding navigation activity rather than a meaningful academic experience.

Participant SD-09 described this phenomenon bluntly: “Often, what is explained in class doesn’t directly connect to the assignments in the online system. I have to make the connections myself, and that’s actually more exhausting than the studying itself” (March 14, 2025). This statement reflects how students perceive the absence of pedagogical continuity between face-to-face and online learning environments. The inconsistency between instructional explanations and digital task structures creates additional cognitive demands that exceed the intended learning objectives. Consequently, students must repeatedly perform independent cognitive reconstruction in order to understand how different instructional components relate to one another.

Several participants further emphasized that fragmented instructional structures create uncertainty regarding learning priorities and expectations. Students frequently reported confusion in distinguishing between core conceptual materials and administrative requirements because instructions were distributed across multiple disconnected channels. In this context, cognitive overload emerges not solely from academic complexity, but from the necessity to continuously adapt to inconsistent pedagogical communication patterns. This finding indicates that blended learning environments may unintentionally generate substantial extraneous cognitive load when instructional coherence is poorly maintained. In addition to structural issues, the technical complexity arising from the use of overlapping learning platforms creates substantial navigation barriers. Students’ mental energy is drained trying to understand how the systems work rather than engaging with the learning content. The necessity to switch repeatedly between learning management systems, video conferencing applications, messaging groups, cloud storage links, and assignment submission portals produces what participants described as “navigation fatigue.” This condition forces students to divide their attention between technological adaptation and conceptual learning simultaneously.

This creates a significant shift in focus, as expressed by AR-11: “In a single week, I might open four different platforms... It feels like I’m not learning the material, but learning how to survive within the system” (March 19, 2025). The phrase “survive within the system” illustrates that students perceive blended learning not merely as an educational process, but as an environment requiring continuous adaptive effort. Rather than experiencing technology as a facilitator of learning, participants frequently interpreted digital systems as additional cognitive obstacles that disrupted concentration and reduced learning efficiency. Moreover, participants reported that excessive platform transitions often interrupted the continuity of information processing. Students explained that after spending significant time navigating technical systems, they experienced reduced motivation and diminished cognitive readiness to engage deeply with academic content. Some participants also expressed frustration regarding repetitive technical adjustments, forgotten passwords, inconsistent notification systems, and unclear digital instructions, all of which contributed to cumulative psychological fatigue.

These narratives indicate an accumulation of extraneous cognitive load that interrupts the flow of information processing. From a phenomenological perspective, students’ lived experiences reveal that cognitive exhaustion emerges gradually through repeated exposure to fragmented pedagogical structures and technological complexity. The findings therefore suggest that the problem within blended learning environments is not merely the presence of technology itself, but the absence of an integrated instructional ecosystem capable of minimizing unnecessary cognitive burdens.

## **The Erosion of Cognitive Integrity: From Meaningful Understanding to Academic Pragmatism**

The impact of this excessive cognitive load leads to a decline in the quality of students' information processing. Findings indicate a shift from a deep approach to learning toward a surface approach. When working memory capacity reaches its maximum threshold, students tend to neglect holistic conceptual understanding and focus only on basic instructional elements. As cognitive demands accumulate, students gradually prioritize efficiency and task completion rather than reflective comprehension and knowledge integration. TNA-12 describes this condition as "mental saturation": "After a few hours in a blended class, it feels like my brain is full... all that's left are the main points" (March 26, 2025). This statement demonstrates how prolonged exposure to cognitively fragmented learning environments reduces students' ability to process information deeply. Participants repeatedly described feelings of cognitive exhaustion characterized by declining concentration, reduced memory retention, and difficulty connecting theoretical concepts across learning sessions. Under these conditions, students no longer engage in analytical or reflective learning processes, but instead attempt to preserve their remaining cognitive resources by simplifying learning targets.

Several participants acknowledged that they increasingly relied on shortcut learning strategies such as memorizing keywords, identifying minimum assignment requirements, and selectively ignoring non-essential information. Although these strategies enabled students to cope temporarily with excessive demands, they also contributed to the gradual erosion of cognitive integrity. Learning became fragmented into isolated instructional tasks rather than a coherent process of conceptual meaning-making. This phenomenon has led to a shift toward a more pragmatic academic orientation. Students' coping strategies have shifted toward completing administrative tasks merely to fulfill requirements, without regard for the quality of their understanding. FH-07 stated: "When there's too much to do, I don't even think about whether I understand it or not. The important thing is to finish the assignment first so I don't fall behind" (March 15, 2025). This statement reflects a transformation in students' academic values, where maintaining submission compliance becomes more important than achieving conceptual mastery.

The findings further reveal that excessive cognitive pressure encourages students to perceive learning success in administrative rather than intellectual terms. Assignment submission, attendance completion, and procedural compliance become dominant indicators of academic achievement. In this context, educational activities are experienced less as opportunities for intellectual growth and more as mechanisms for avoiding academic penalties or maintaining course survival. This pragmatic orientation emerges as a defensive adaptation to persistent cognitive overload. In the context of the teaching profession, participants expressed concern regarding their future roles, with several noting that normalizing administrative task completion over pedagogical depth could impact their future performance as elementary teachers. Participants feared that prolonged exposure to fragmented and survival-oriented learning cultures might influence how they later design and facilitate learning for their own students. Some participants explicitly questioned whether they would be able to foster meaningful learning experiences in elementary classrooms if their own educational experiences were dominated by cognitive fatigue and procedural pragmatism.

Furthermore, several participants described feelings of guilt and anxiety when realizing that they were gradually losing enthusiasm for reflective learning. Although students remained academically active, many admitted that their engagement had become increasingly mechanical and performance-oriented. This finding indicates that cognitive overload does not merely affect information processing capacity, but also reshapes students' emotional relationships with learning itself. Collectively, these findings demonstrate that excessive extraneous cognitive load contributes not only to cognitive exhaustion, but also to the transformation of academic identity and learning orientation. The erosion of cognitive integrity observed in this study reflects a broader phenomenological shift in which students adapt to blended learning

environments by prioritizing survival, efficiency, and procedural completion over meaningful understanding and pedagogical reflection.

## Discussion

### Cognitive Overload as a Failure of Cognitive Ergonomics in Mixed-Use Design

The findings of this study reinforce the argument that cognitive overload in blended learning is a direct consequence of cognitive ergonomics failures in instructional design. The fragmentation between online and in-person modes creates what Cognitive Load Theory (CLT) refers to as the split-attention effect, in which students must constantly divide their attention to integrate separate sources of information (Guzm & R, 2024; Skulmowski, 2023). In line with previous research, the technical complexity identified in this study confirms that high extraneous load mechanically hinders the formation of complex mental schemas (Surbakti & Umboh, 2024). Therefore, the synchronization of instructional design is not merely an administrative issue but a pedagogical prerequisite for ensuring students' cognitive efficiency. For PGSD students, this design failure is not merely an academic obstacle but a systemic failure in providing a learning experience that serves as a role model for them in designing effective elementary school instruction in the future. Ultimately, this underscores a critical need for a total reconstruction of blended learning designs shifting away from purely technological-oriented implementation toward a framework strictly anchored in the principles of cognitive ergonomics to safeguard the quality of teacher professional preparation.

### The Paradox of Digitalization and the Risk of Academic Burnout in Modern Education

There is a paradox between the flexibility of technology and students' cognitive well-being. Although blended learning offers broad accessibility, without proper management of cognitive load, this model actually triggers persistent mental fatigue. The decline in motivation and academic stress reported by students aligns with the risk of a degraded learning experience in non-intuitive digital environments (Iuga & David, 2024; Liu et al., 2023). This sustained mental fatigue does not merely affect a single learning session but has spillover effects that reduce students' learning resilience over the long term. This calls for a reorientation of learning design toward a more human-centered approach that is sensitive to human working memory capacity. In the context of elementary education, mental fatigue among PGSD students risks lowering their pedagogical ideals, shifting their focus from designing creative learning experiences for young children to merely fulfilling the demands of exhausting technical tasks.

### Metacognitive Autonomy and the Vital Role of Self-Regulated Learning (SRL)

Despite facing intense cognitive pressure, the identification of adaptive strategies in this study highlights the central role of Self-Regulated Learning (SRL) as a cognitive protective mechanism (Peltzer et al., 2026). Students' ability to engage in metacognitive navigation such as prioritizing tasks and filtering digital information indicates that self-regulation acts as a mediator between systemic demands and individual capacity. These findings support research indicating that, within complex learning ecosystems, metacognitive competencies are the primary determinants of academic success (Anthony'samy, 2021). Therefore, strengthening metacognitive literacy must be a priority on the institutional agenda to equip students with adequate navigational tools in the digital age. This urgency is increasingly crucial for prospective elementary school teachers to ensure their mental readiness and self-efficacy in adaptively integrating technology into future classrooms.

### Practical Implications for Institutional Transformation

In practical terms, the findings of this study provide a strong mandate for higher education institutions, particularly Teacher Education Institutions (TEIs) such as *IKIP PGRI Wates*, to design a blended curriculum policy that is more coherent and minimizes technical distractions. Reducing the cognitive load through platform standardization and simplifying instructions are urgent steps. Elementary education faculty members need to set an example in developing cognitively ergonomic instructional designs, so that PGSD students have a concrete model when they eventually need to create digital teaching

materials for elementary school students. By integrating the principles of Cognitive Load Theory into practical design, institutions can create a learning ecosystem that is not only technologically innovative but also cognitively sustainable for the nation's future educators.

## Conclusion

This study concludes that cognitive overload among prospective elementary school teachers is a multidimensional phenomenon driven by fragmented instructional design and techno-systemic complexity. Empirical evidence from participant narratives (e.g., SD-09 and AR-11) confirms that "navigation fatigue" and "pedagogical discontinuity" are the primary catalysts for this overload. These conditions trigger a significant degradation in information processing, shifting student orientation from deep conceptual understanding to administrative pragmatism. However, reflective journals and interview data reveal that Self-Regulated Learning (SRL) acts as a vital metacognitive resilience mechanism, enabling students to mitigate mental fatigue through information filtering and task prioritization. Consequently, higher education administrators particularly at *IKIP PGRI Wates* must standardize digital ecosystems and synchronize pedagogical narratives to reduce extraneous load. Furthermore, faculty members should integrate explicit self-regulation training to equip future educators with the cognitive navigation skills necessary to design healthy learning environments in elementary schools.

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