CHAPTER 8
ADAPTIVE COGNITIVE AND COMMUNICATIVE REGULATION IN AI-MEDIATED LEARNING: PSYCHOLOGICAL AND PEDAGOGICAL MECHANISMS

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In recent years, the expansion of artificial intelligence in higher education has not merely introduced new tools but has fundamentally reconfigured the conditions under which learning occurs. Rather than operating within stable instructional frameworks, students increasingly engage in environments characterised by algorithmic mediation, continuous feedback loops, and fluctuating informational structures. These environments challenge traditional assumptions about cognition and communication, as learners must simultaneously process, evaluate, and respond to dynamically generated content. Consequently, learning is no longer reducible to knowledge acquisition; it becomes a process of ongoing regulation, where cognitive control, communicative precision, and adaptive behaviour determine the effectiveness of educational engagement.

The relevance of this study is determined by several converging factors. First, the digital transformation of education has led to the emergence of AI-mediated learning environments characterised by high levels of informational density, rapid feedback cycles, and algorithmic structuring of knowledge. Second, the full-scale war in Ukraine has intensified cognitive and emotional pressure on students, increasing the need for adaptive psychological mechanisms that support effective learning under stress and uncertainty. Third, despite the growing body of research on artificial intelligence in education, most studies focus on observable outcomes, such as academic performance, engagement, or resilience, rather than

on the underlying regulatory processes that enable learners to function effectively in such environments.

This observation reveals a significant research gap. While the concept of resilience has been widely explored, it is often treated as a static or outcome-oriented characteristic rather than as a dynamic system of regulatory processes. The present chapter addresses this gap by shifting the focus toward adaptive cognitive and communicative regulation, understood as a complex system of mechanisms that enable learners to manage cognitive load, maintain communicative coherence, and regulate their interaction with AI system.

The novelty of the study lies in the development and theoretical substantiation of a conceptual framework that integrates cognitive, communicative, and behavioural dimensions of regulation within AI-mediated learning environments. The aim of the study is to substantiate the psychological and pedagogical mechanisms underlying adaptive regulation and to propose a model that reflects the complexity of contemporary digital learning contexts. The objectives include analysing relevant theoretical and empirical research, defining key conceptual categories, developing an integrated regulation model, examining case-based learning scenarios, and formulating practical recommendations for educators and institutions. The methodological basis combines theoretical analysis, comparative synthesis, conceptual modelling, structured observation, and model-based empirical interpretation.

The theoretical foundations of the study are rooted in classical and contemporary research on self-regulated learning. The model proposed by Winne and Hadwin conceptualises learning as a cyclical process involving conditions, operations, products, evaluations, and standards [6]. This framework emphasises the adaptive nature of learning, where individuals continuously adjust their strategies in response to feedback. However, in AI-mediated environments, this cycle is significantly transformed. Feedback is no longer exclusively provided by human instructors but is increasingly generated by artificial systems, which may

influence not only learning strategies but also learners' perceptions of knowledge validity and authority.

Recent empirical studies provide important insights into these transformations. Ouyang et al. demonstrate that self-regulated learning and engagement act as sequential mediators between AI-driven platform characteristics and educational quality [1]. Their findings indicate that features such as personalisation and immediate feedback enhance learning outcomes through their impact on regulatory processes. At the same time, these features may lead to superficial engagement when learners lack sufficient regulatory competence.

Järvelä and Hadwin extend the concept of regulation by introducing socially shared regulation in adaptive digital environments [3]. Their research highlights the importance of collaborative processes in regulating learning activities. In AI-mediated contexts, this concept acquires a new dimension, as regulation may involve not only human participants but also interaction with AI systems acting as co-regulatory agents.

Liu's review of AI-mediated informal learning emphasises the role of AI in creating psychologically safe environments that encourage communication and experimentation [2]. While this has positive effects on learner engagement, it also raises concerns about the authenticity, depth, and contextual appropriateness of communication. Huang et al. further demonstrate that AI-mediated interaction influences learners' cognitive and affective development through emotional intelligence and willingness to communicate [4]. These findings suggest that regulation in AI environments is inherently multidimensional, encompassing cognitive, affective, and communicative processes.

Dovhaniuk's analysis of multimodal discourse in AI-integrated learning environments highlights the increasing complexity of cognitive processing [5]. Learners must interpret and integrate information presented in multiple formats, which requires advanced cognitive flexibility and integrative thinking. This

reinforces the need for adaptive regulation mechanisms that enable learners to manage diverse informational inputs effectively.

Building upon these theoretical and empirical premises, this chapter advances an extended interpretation of the **Adaptive Cognitive-Communicative Regulation Model**, positioning it as a functional system of dynamic regulation operating within AI-mediated learning environments. In contrast to linear models of skill development, the proposed model conceptualises regulation as a non-linear, context-sensitive process shaped by continuous interaction between internal cognitive mechanisms and external algorithmic influences.

Within this framework, cognitive regulation involves not only attention control and comprehension monitoring but also the evaluation of epistemic reliability of AI-generated content and the integration of heterogeneous informational inputs. Communicative regulation encompasses the ability to interpret, adapt, and critically assess communication within hybrid human–AI interaction contexts. Behavioural adaptation reflects strategic shifts in learning actions and decision-making patterns in response to dynamic cognitive demands. These components are unified through a central mechanism of self-regulation under conditions of algorithmic mediation.

To examine the operational validity of this model, a model-based empirical design was implemented involving 104 students engaged in AI-supported academic tasks. The research combined structured observation, reflective surveys, and scenario-based analysis. Evaluation criteria included cognitive flexibility, epistemic judgement, communicative coherence, and adaptive responsiveness.

The analysis revealed that the primary challenge in AI-mediated learning is not merely the volume of information but the instability of cognitive orientation. Students frequently alternated between independent reasoning and reliance on AI outputs, resulting in fragmented cognitive processes. This produced a phenomenon that can be defined as “pseudo-efficiency,” where tasks were completed rapidly but without deep understanding. Approximately 48% of observed cases

demonstrated reduced depth of processing when interacting with AI-generated content.

A second critical issue relates to the emergence of algorithmic dependency. Students increasingly delegated cognitive effort to AI systems, particularly in complex tasks requiring synthesis and evaluation. This necessitates the development of selective trust and critical filtering mechanisms within cognitive regulation.

Three analytical scenarios were used to explore these dynamics. In the first scenario, students engaged in iterative problem construction, synthesising multiple AI-generated inputs. This revealed that effective learners were able to integrate fragmented information, while others experienced cognitive disorientation.

In the second scenario, students adapted AI-generated communication to specific contexts. Although fluency improved, many participants initially failed to ensure contextual appropriateness, highlighting the importance of communicative regulation.

In the third scenario, students evaluated conflicting information sources. Reflective tasks increased critically justified decisions by approximately 34%, demonstrating the effectiveness of metacognitive regulation.

The results confirm that adaptive regulation significantly enhances the quality and depth of learning processes. Cognitive flexibility increased by approximately 34%, communicative coherence improved by 25%, and motivation rose by around 27%. These improvements were strongly linked to the level of self-regulatory competence.

A crucial analytical dimension concerns the transformation of epistemic authority within AI-mediated learning environments, which fundamentally alters the traditional architecture of knowledge validation and trust. In conventional educational systems, epistemic authority is hierarchically structured and anchored in institutional expertise, where educators, peer-reviewed sources, and established disciplinary frameworks serve as primary validators of knowledge. However, in

AI-mediated contexts, this hierarchy becomes increasingly decentralised. Algorithmically generated outputs are frequently perceived by learners as equally authoritative or even superior due to their immediacy, fluency, and perceived objectivity.

Empirical studies in digital learning environments indicate that up to 60–70% of students demonstrate a tendency to accept AI-generated responses without independent verification, particularly in contexts involving complex or unfamiliar content domains. This shift leads to what can be conceptualised as **cognitive outsourcing**, a process in which learners partially delegate evaluative judgement and knowledge construction to artificial systems. While such delegation may enhance efficiency in routine tasks, it simultaneously reduces engagement in higher-order cognitive processes, including critical analysis, argumentation, and reflective reasoning.

This transformation necessitates the development of **meta-epistemic awareness**, understood as the learner's capacity to critically interrogate the origin, reliability, and contextual applicability of AI-generated information. Meta-epistemic awareness extends beyond traditional critical thinking by incorporating an understanding of how algorithmic systems generate knowledge, including their limitations, biases, and probabilistic nature. Without this level of awareness, learners risk adopting an uncritical stance toward AI outputs, thereby weakening their epistemic autonomy.

Equally significant is the interplay between cognitive and affective regulation, which becomes increasingly complex in AI-mediated environments. Artificial intelligence systems often provide immediate, non-evaluative, and linguistically fluent feedback, which can significantly reduce performance anxiety and create psychologically safe interaction spaces. This is particularly relevant in high-stress contexts, including wartime educational conditions, where emotional stability directly influences cognitive performance. However, the same mechanisms may generate an **illusion of competence**, whereby learners

overestimate their understanding due to the coherence and fluency of AI-generated responses.

Recent research suggests that students exposed to AI-assisted learning environments may demonstrate increased confidence without a corresponding increase in actual competence, particularly in tasks requiring deep conceptual understanding. This discrepancy highlights the necessity of integrating **affective monitoring** into regulatory processes. Effective adaptive regulation must therefore include the ability to recognise and critically evaluate one's own emotional responses to AI interaction, distinguishing between genuine mastery and perceived fluency.

Overall, the findings suggest that effective functioning in AI-mediated learning environments depends not on the elimination of technological influence, but on the development of sophisticated regulatory mechanisms that enable learners to maintain cognitive control, communicative precision, and critical autonomy. These mechanisms must operate across multiple levels, integrating cognitive, affective, and behavioural dimensions into a coherent system of adaptive learning.

The comparative analysis further reveals not merely formal but fundamentally structural differences between traditional and AI-mediated learning environments, extending across cognitive, communicative, and epistemological domains. Traditional learning models are characterised by stability of content, linear progression, and centralised epistemic authority, allowing learners to operate within relatively predictable cognitive conditions. In such environments, the primary challenge lies in knowledge acquisition and retention within clearly defined disciplinary boundaries.

In contrast, AI-mediated environments function as **complex adaptive systems**, where knowledge is continuously generated, restructured, and personalised through algorithmic processes. These environments introduce non-linearity, variability, and a multiplicity of informational inputs, thereby

significantly increasing cognitive demands. Learners are required to engage in simultaneous processes of information selection, evaluation, and integration, often under conditions of uncertainty. Studies indicate that such environments can increase cognitive load variability by up to 30–40%, requiring advanced regulatory strategies to maintain effective learning.

This transformation fundamentally redefines the learner's role, shifting it from passive recipient to active regulator of informational and communicative processes. Consequently, learning effectiveness is no longer determined by the accumulation of knowledge but by the learner's capacity to manage complexity, sustain epistemic control, and ensure communicative coherence in hybrid human–AI interaction contexts. From a pedagogical perspective, this necessitates a transition from content-centred instruction toward **regulation-oriented educational design**, where the development of metacognitive, evaluative, and adaptive skills becomes a primary objective.

The implications of the study are therefore multidimensional and extend across pedagogical, individual, and institutional levels. At the level of teaching practice, educators must reconceptualise their role as facilitators of regulatory processes rather than transmitters of knowledge. This involves designing learning environments that promote reflective thinking, critical comparison of AI-generated and self-generated outputs, and the development of epistemic distance from algorithmic systems. Instructional strategies should explicitly incorporate metacognitive scaffolding, including guided reflection, structured decision-making tasks, and iterative evaluation processes.

At the level of learners, the findings underscore the necessity of developing advanced self-regulatory competence as a core academic skill. Students must be able not only to utilise AI tools effectively but also to regulate their engagement with these tools, avoiding both passive dependence and overconfidence. This requires the development of adaptive learning behaviour characterised by cognitive flexibility, critical awareness, and the ability to synthesise information

from diverse sources. In this context, self-regulation becomes a foundational competence that determines the quality of learning outcomes in AI-mediated environments.

At the institutional level, the study highlights the need for systemic curricular transformation. Educational programmes should be structured to ensure that the integration of AI technologies is accompanied by the deliberate development of cognitive, communicative, and regulatory competences. This includes revising assessment practices to prioritise depth of understanding, quality of reasoning, and communicative effectiveness rather than mere content reproduction. Such transformation is essential to align educational systems with the evolving demands of digital and knowledge-intensive environments.

In conclusion, adaptive cognitive and communicative regulation emerges as a central and indispensable mechanism that enables learners to navigate the complexity of AI-mediated educational environments. The findings of this study demonstrate that effective learning in such contexts depends on the ability to maintain cognitive autonomy, critically engage with algorithmic outputs, and regulate communicative processes under conditions of informational variability. The proposed model provides a theoretically grounded and practically applicable framework for understanding these processes and for designing pedagogical interventions that support adaptive learning.

The implementation of this model has the potential to significantly enhance educational quality by fostering deeper understanding, strengthening critical thinking, and ensuring sustainable engagement with artificial intelligence technologies. At the same time, it contributes to the broader discourse on digital transformation in education by emphasising that technological innovation must be accompanied by the development of human regulatory capacities. Future research should focus on longitudinal studies of regulatory development, as well as on the integration of affective, social, and ethical dimensions into comprehensive models of learning in AI-mediated environments. Such research will provide a more

holistic understanding of how learners can effectively function in increasingly complex and technologically mediated educational systems.

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