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Integrative Connectomic Theory in Neuroscience and Educational Sciences

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Abstract

The Integrative Connectomic Theory (ICT) provides a unified conceptual framework for understanding how large-scale brain networks generate cognitive, emotional and behavioral functions, while also offering a coherent foundation for the learning sciences and contemporary curriculum theory. Moving beyond region-based models, ICT emphasizes the dynamic coordination among major functional networks—such as the Default Mode Network (DMN), Central Executive Network (CEN), and Salience Network (SN)—as the basis of attention, executive control, emotional regulation and conceptual integration. Through oscillatory dynamics, network switching and cross-frequency coupling, ICT connects neurobiological mechanisms with key educational processes including cognitive engagement, motivation, self-regulation and adaptive learning. These insights have direct implications for curriculum design by supporting competence-based approaches, personalized learning pathways and neurodidactic principles that align instructional progression with learners' cognitive architecture. ICT also sheds light on how cognitive load, stress regulation and developmental variability emerge from network-level interactions, offering valuable guidance for optimizing learning environments and ensuring sustainable educational outcomes. By bridging neuroscience and educational sciences, the theory contributes both to theoretical consolidation and to the development of curriculum models grounded in neural connectivity and human development.

Keywords: Adaptation, Cognitive Networks, Curriculum Design, Neurodynamics, Self-Regulation