

Chapter 13

Merging AIoE technology With Brain-Inspired Computing in Education

Zornitsa Yordanova

 <http://orcid.org/0000-0002-6056-8445>

University of National and World Economy, Bulgaria

ABSTRACT

This research explores the convergence of Artificial Intelligence of Everywhere (AIoE) and neuromorphic computing in intelligent learning analytics. By explaining the theoretical concepts, system architecture, application scenarios, and ethical challenges, it is shown that this combination can transform educational environments into adaptive, human-centered, and personalized systems through real-time processing of cognitive and biological data. Along with the opportunities, issues such as cognitive privacy, informed consent, and algorithmic bias are also analyzed. The research emphasizes the necessity of responsible and human-centered design of these technologies for the future of education.

1. INTRODUCTION

In the present era, education is no longer a passive and linear activity, but has become a complex, dynamic, and multi-agent system that involves continuous interaction between the learner, content, digital platforms, and the surrounding environment. With the explosive growth of smart technologies, especially the Internet of Things, edge computing, and embedded artificial intelligence, a new concept called “Artificial Intelligence of Everything” (AIoE) is emerging; a concept in which all components of the digital environment have the ability to process, learn, and make

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decisions (Szmelter-Jarosz & Nozari, 2025). This fundamental transformation has created a new perspective for learning analytics and the development of intelligent educational systems; a perspective in which not only traditional educational data but also biological, behavioral, emotional, and even cognitive data are collected, processed, and analyzed in real time.

Alongside these developments, brain-inspired computing, or neuromorphic computing, is also emerging as a key component of future technologies. This approach attempts to recreate the neural structure and functions of the brain at the hardware and software levels, rather than simply imitating classical AI algorithms (Li, G., Deng, L., Tang, H., Pan, G., Tian, Y., Roy, K., & Maass, W. (2024). Using traditional neural circuits, spiking circuits, and event-driven neural networks, neuromorphic systems are capable of very fast, low-power, and instantaneous processing of data coming from sensors or the surrounding environment (Nozari & Szmelter-Jarosz, 2024). From this perspective, neuromorphic computing is considered a powerful complement to the AIOE ecosystem, as it can provide deeper analyses of the learning process with high adaptability and low energy, especially in sensitive and real-time educational environments. One of the serious gaps in today's learning analytics is the inability to understand the cognitive and neural layers of learner behavior. While many learning analytics systems are built on clicks, superficial interactions, or performance scores, AIOE and neuromorphic-based systems are able to understand and analyze brain data such as EEG, galvanic skin responses, eye movements, and heart rate (Rahmaty & Nozari, 2023). This capability allows learning analytics to achieve a more dynamic, multi-layered, and perceptual model of an individual's learning and mental processes rather than a superficial and static picture. Accordingly, an intelligent learning environment can automatically adjust the content and learning path by understanding the cognitive load, fatigue, excitement, or momentary focus of the learner (Szmelter-Jarosz, Ghahremani-Nahr, & Nozari, 2021).

The convergence of AIOE and neuromorphic computing not only creates new technical possibilities in learning analytics, but also is revolutionary in terms of educational philosophy. In this approach, the learner is not only considered as a recipient of content but also as an intelligent node in a connected perceptual network; a node capable of two-way data exchange (Guo, X. 2022), biocompatibility, and mutual influence on the educational system. Such a view will lead to the formation of a new generation of "cognitive twins"; digital representations of the individual's neural, emotional, and cognitive state that can play a key role in the design of personalized educational experiences (Nozari, 2023). However, the realization of such systems is not possible without considering ethical challenges and concerns. Although the collection and analysis of neural data is aimed at improving education, it faces issues such as cognitive privacy, informed consent, and the risk of biased analyses (Aliahmadi & Nozari, 2023). For this reason, the convergence of AIOE and

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