

Harnessing Neuroadaptive Technologies and AI in Personalized Education: the PD AkademiX Approach Towards Resilient Educational Operations

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Abstract

The global educational landscape is increasingly pressured by diverse disruptions—ranging from pandemics and geopolitical conflicts to rapidly evolving labor market demands. As highlighted by UNESCO (2023) and the OECD (2022), traditional, uniform educational models are struggling to deliver resilience and personalized learning outcomes in this volatile context. Responding to this gap, the PD AkademiX project pioneers an AI-driven, neuroadaptive educational platform designed to dynamically adjust instructional strategies and psychological support for individual learners, particularly those facing anxiety and learning difficulties.

This keynote presentation at the 3rd IEOM GCC 2025 Conference explores how PD AkademiX aligns with core principles of industrial engineering and operations management (IEOM) by integrating concepts such as:

- **Systems Thinking:** Modeling the educational process as a complex socio-technical system where human cognition and technological adaptation continuously interact (Checkland, 1999; Serman, 2000).
- **Lean Operations and Process Optimization:** Leveraging AI analytics to identify cognitive bottlenecks, minimize educational “waste,” and maximize learning throughput (Liker, 2004; Ohno, 1988).
- **Quality Engineering and Statistical Process Control:** Employing real-time monitoring of affective and cognitive states to ensure consistent educational quality and timely interventions (Montgomery, 2020).
- **Digital Twin Technology:** Proposing virtual “learner twins” to simulate learning trajectories and proactively manage personalized educational pathways (Tao et al., 2018).

PD AkademiX deploys NLP-based emotional analysis and adaptive content delivery mechanisms to create real-time, data-driven interventions. This approach not only enhances individual learning outcomes but also contributes to operational efficiency and resource allocation at institutional levels—critical objectives within the IEOM domain.

Moreover, the platform introduces a novel metric framework to quantify psychological resilience as a dimension of operational performance, pushing the boundaries of traditional key performance indicators in educational management.

This keynote will critically examine both the opportunities and risks inherent in such neuroadaptive systems—including algorithmic bias, data privacy concerns (GDPR, KVKK), and the socio-ethical implications of AI-based psychological profiling (Floridi et al., 2018). Participants will gain insights into how educational institutions can incorporate advanced IEOM tools to engineer more personalized, resilient, and sustainable educational operations for the post-digital era.

Keywords

Neuroadaptive learning, Industrial engineering, Operations management, AI in education, Personalized learning

Biography

Semai Ülgen is a Professor in Industrial Engineering Department at Antalya Bilim University, Antalya, Turkey. She earned B.S. in Mathematics from Bilkent University of Faculty of Science, Turkey, Masters and PhD in Mathematics from Purdue University, West Lafayette, IN, USA. She has published journal and conference papers. She had worked as a professor at the University of Mississippi, Oxford, MS, USA, at Grand Valley State University, Allendale, MI, USA, at Northwestern University, IL, USA and at Indiana University, Bloomington, IN, USA. Dr. Ülgen was a recipient of the Young Scientist Award for Turkish American Scientists and Scholars Association (USA). Her research interests include Finsler Geometry, Applications to Mathematical Physics, Stochastic Processes and its Applications. She is a member of IEOM, AMS, Turkish Mathematical Society. She owns a research and trade company (INNOSU) on water efficiency in agriculture and industry.