

Cognitive Load-Based Multilingual Co-Learning Architecture for AI-Enhanced Education

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Abstract

The rapid growth of online educational content, particularly video-based learning resources, has created new opportunities as well as challenges for learners. While vast amounts of material are readily available, identifying relevant content in a preferred language, within limited time, and at an appropriate level of complexity remains difficult. Moreover, variations in presentation style, duration, and structure often lead to cognitive overload, reducing learning effectiveness. According to Cognitive Load Theory, human working memory is inherently limited, requiring careful selection and organization of information during learning.

This keynote presents a **Cognitive Load-Aware Multilingual Co-Learning Architecture**, which integrates cognitive principles with AI-driven content processing to support efficient and adaptive learning. The proposed co-learning model views learning as a **connective and structured process**, where knowledge elements are refined, reorganized, and interconnected to align with learners' cognitive constraints. Rather than treating learning content as static, the system dynamically transforms raw multimedia resources into cognitively optimized learning units.

Technically, the framework leverages natural language processing and multimodal AI techniques, including speech refinement, subtitle generation, multilingual dubbing, summarization, classification, keyword extraction, and automatic quiz generation. These components are orchestrated to reduce extraneous cognitive load, enhance intrinsic understanding, and support germane cognitive processing. The system further enables cross-lingual accessibility, allowing learners to engage with content regardless of language barriers while maintaining conceptual coherence.

A preliminary evaluation demonstrates strong user acceptance, with a 93% satisfaction rate in classroom deployment scenarios. Learners reported improved comprehension, reduced cognitive burden, and increased engagement due to the structured and adaptive presentation of learning materials.

This work highlights the importance of integrating cognitive load theory with AI-based content transformation, positioning co-learning systems as a scalable solution for multilingual, learner-centered education. By aligning content delivery with human cognitive constraints, the proposed architecture contributes to more effective, inclusive, and intelligent educational environments.