

BLENDING LEARNING IN COMPUTER SCIENCE TEACHER TRAINING

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Abstract. This research aims to contribute to the discourse on blended learning approaches in Computer Science teacher training programs in Ukraine. The objectives are twofold: 1) to determine the appropriate Ukrainian scientific term for “blended learning” given Ukraine’s ongoing European integration, and 2) to provide a comprehensive definition of “blended learning” by synthesizing various academic conceptualizations. The object of study is the concept of “blended learning” itself and how it can be applied to train future Computer Science teachers with the necessary digital competencies. The purpose is to support the professional development of educators so that they can effectively prepare students for success in the digital age. The methods employed include linguistic analysis of how “blended learning” is translated across European languages and an extensive literature review to synthesize definitions from prior research into a unified conceptual understanding. The key results are: 1) the proposed Ukrainian term “kombinovane navchannia” reflects an adaptive combination of learning modes; 2) a comprehensive definition views blended learning as an adaptive, pedagogically balanced integration of face-to-face, online, formal, informal, individual and collaborative learning facilitated by intelligent ICTs like machine learning, big data analytics, virtual reality, and AI tutoring systems. The findings highlight how blended learning provides access to rich educational data that can be processed by intelligent technologies to enable personalized, immersive experiences and predictive learning analytics. Promising future dimensions across philosophical, psycho-physiological, sociological, organizational, technological and synergistic factors are discussed.

Keywords: blended learning, Computer Science education, teacher training, educational technologies, kombinovane navchannia, intelligent ICTs.

Introduction. The digital transformation of education has become an imperative in today's rapidly changing world. The European Union has recognized the importance of this transformation through initiatives like the Digital Education Action Plan 2021-2027 and the Council Recommendation on blended learning approaches for high-quality and inclusive primary and secondary education. One key aspect emphasized in these initiatives is the integration of digital technologies into teaching and learning processes through blended learning approaches.

Blended learning has emerged as a powerful paradigm that combines the benefits of traditional face-to-face instruction with the flexibility and accessibility of online learning [1]. In the context of Computer Science teacher training, blended learning holds particular relevance as it can equip future educators with the necessary digital competencies to effectively prepare students for the digital age.

“Council conclusions on European teachers and trainers for the future” emphasize that teachers are a driving force that should be involved in the development of education and training policies and supported through a comprehensive approach to their teacher education, teacher training, and continuing professional development, including digital competencies. In addition, the European Commission’s structured dialogue with EU Member States on digital education and digital competencies has highlighted the challenges faced by most Member States in recruiting (attracting), retaining, and training teachers, especially Computer Science teachers (for primary, secondary and vocational education) [2, 12].

The goal of the work. This paper aims to contribute to the discourse on blended learning in Computer Science teacher training by addressing two main objectives: 1) to substantiate the appropriate Ukrainian scientific term for “blended learning” in light of Ukraine’s ongoing European integration processes; 2) to provide a comprehensive definition of the term “blended learning” by synthesizing various academic perspectives and conceptualizations.

Formulation of the problem. In pursuing these objectives, the study confronts several critical contradictions: a) the discrepancy between the European requirements for the professional competencies of Computer Science teachers and the lack of well-defined national standards for Computer Science teacher training in Ukraine; b) the untapped potential of intelligent technologies in education and the absence of established methods for leveraging these technologies in the

implementation of blended learning; c) the necessity to develop professional competence in blended learning for future Computer Science teachers, coupled with the lack of a well-defined structure, components, and diagnostic tools to facilitate this development.

To address the first objective, we conduct a linguistic analysis of the term “blended learning” by examining its various translations and interpretations across European languages [3]. This analysis leads to the conclusion that the most appropriate Ukrainian scientific term is “kombinovane navchannia”, reflecting the notion of an adaptive combination and integration of different learning modalities.



Fig. 1. Definition of “blended learning” on the European map: countries that use the word “combining” are marked with a green marker, “mixing” with a red marker, “mixing” and “combining” with a blue marker

Regarding the second objective, we synthesize various academic definitions and perspectives to arrive at a comprehensive understanding of blended learning. Based on this synthesis, we define blended learning as a planned, pedagogically balanced, adaptive combination, interpenetration, and integration of technologies (face-to-face and distance learning, formal and non-formal learning, real and virtual, individual and collective learning) to optimally meet the educational needs of the subjects of the educational process using intelligent ICTs.

A central aspect highlighted in this definition is the role of intelligent technologies, such as machine learning models and methods for processing big data on the educational process. These technologies hold the potential to predict potential crises at the learner and system levels, enabling adaptive and personalized learning experiences:

1. Learning analytics and personalization intelligent ICTs like machine learning models can analyze data on learner activities, engagement, emotions, stress levels etc. to enable individualization and personalization of learning paths, activities, and assessments based on each learner’s needs [4].

2. Automated support and feedback AI systems can automatically monitor online sessions, identify patterns of interest/disengagement, and provide customized support, feedback and interventions in real-time to keep learners engaged and on-track [5].

3. Virtual and immersive learning technologies like virtual reality, augmented reality and AI-driven simulations can create highly immersive and experiential learning environments, especially valuable for domains like computer science which require interaction with abstract concepts [6].

4. AI-powered tutoring systems can guide learners through concepts, provide step-by-step problem-solving support, and adapt their inputs based on the learner's knowledge state [7].

Conclusions. The answers to the research questions obtained in the course of the study made it possible to define blended learning terminologically as combined learning and content-wise as a planned, pedagogically balanced, adaptive combination, interpenetration and integration of technologies (full-time and distance learning, formal and non-formal learning, real and virtual, individual and collective learning) to optimally meet the educational needs of the subjects of the educational process using intelligent ICTs.

The implementation of blended learning provides access to big data on the educational process and the possibility of using intelligent technologies (primarily machine learning models and methods) to process them and predict possible crises at the level of learners and the system as a whole. In particular, intelligent technologies make it possible to determine the degree of interest of participants in an online class, their emotional state, stress level, etc., which creates conditions for automating individualization and personalization of learning. Therefore, the main concepts that need to be considered for the development of a blended learning system should be: personalization of learning, intellectualization, big data, learning analytics, virtualization of learning, and immersion based on student experience.

Looking ahead, we outline several promising dimensions of blended learning, including philosophical – the ratio of real and model (virtual) in learning; psychophysiological – individualization of learning based on the emotional state, stress level, etc.; sociological – the ratio of individual and collective, face-to-face and distance learning, desired and forced mobility of learners; organizational and pedagogical – the ratio of formal and informal learning; information technology – the ratio of traditional and intelligent technologies in learning, accessibility and scientificity, real and virtual visibility; synergistic – the ratio of classical machine learning methods and methods of studying complex systems to identify crisis phenomena.

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