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ANALYSIS OF THE MODERNIZATION OF COGNITIVE-DIDACTIC MECHANISMS OF THE DIGITAL-IMMERSIVE MULTISENSORY ENVIRONMENT IN THE HIGHER PEDAGOGICAL EDUCATION SYSTEM

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Abstract. This article analyzes the issues of modernizing the cognitive-didactic mechanisms of the digital-immersive multisensory environment in the higher pedagogical education system. The study investigates the impact of virtual and augmented reality technologies, generative artificial intelligence, multimodal instruction, and neurodidactic approaches on the effectiveness of English language teaching. In addition, mechanisms for developing students' cognitive activity, communicative competence, motivation, and emotional engagement through multisensory pedagogical technologies are proposed. The research findings contribute to improving the quality of English language education and creating an innovative didactic environment in higher education institutions.

Keywords: digital-immersive environment, multisensory didactics, cognitive mechanisms, generative artificial intelligence, virtual reality, augmented reality, multimodal learning, neurodidactics, adaptive learning, English language education.

Introduction. In recent years, extensive research has been conducted on digital pedagogy, immersive technologies, and the development of multisensory didactic environments in higher education. Foreign scholars have investigated the impact of virtual reality (VR), augmented reality (AR), generative artificial intelligence, and multimodal learning technologies on students' cognitive activity and learning motivation. Mayer's multimodal learning theory, Vygotsky's socio-constructivist approach, and neurodidactic concepts are recognized as the theoretical foundations for the formation of digital-immersive educational environments. Contemporary studies emphasize that multisensory approaches enhance the effectiveness of English language acquisition through visual, auditory, and interactive perception of educational materials. In addition, generative artificial intelligence technologies significantly expand the possibilities of adaptive and individualized learning. However, the comprehensive modernization of cognitive-didactic mechanisms within a digital-immersive multisensory environment in higher pedagogical education has not yet been sufficiently studied.

Research Purpose. The purpose of this study is to improve the cognitive-didactic mechanisms of the digital-immersive multisensory environment in teaching English within higher pedagogical education and to enhance educational effectiveness through innovative pedagogical technologies.

Research tasks:

1. To analyze the theoretical and methodological foundations of the digital-immersive multisensory didactic environment.
2. To identify the pedagogical potential of virtual and augmented reality technologies in English language teaching.
3. To investigate the influence of generative artificial intelligence and adaptive platforms on students' cognitive activity.

4. To develop cognitive-activating mechanisms based on multimodal and neurodidactic approaches.

5. To evaluate the effectiveness of multisensory technologies in English language instruction through experimental research.

6. To develop practical recommendations for organizing an innovative didactic environment in higher pedagogical education.

Research Methodology. The study was based on systemic, competency-based, neurodidactic, and multimodal pedagogical approaches. The research employed methods such as pedagogical observation, questionnaires, testing, interviews, experimental studies, comparative analysis, monitoring, and statistical analysis. In addition, educational processes based on virtual reality, augmented reality, generative artificial intelligence, and adaptive digital platforms were analyzed. The reliability of the obtained results was ensured through mathematical-statistical methods and comparative analysis of the indicators of experimental and control groups.

Research Methods. During the research process, such methods as pedagogical observation, questionnaires, interviews, testing, diagnostics, pedagogical experimental trials, content analysis, comparative analysis, monitoring, and mathematical-statistical analysis were employed. In addition, the effectiveness of a digital-immersive multisensory didactic environment based on generative artificial intelligence, virtual reality, and augmented reality technologies in English language teaching was experimentally evaluated.

Schedule 1.

Month / Stage	Technology Type	Learning Activity	Survey Indicators (%)	Pedagogical Purpose	Expected Outcome
September	Diagnostic adaptive platform	Assessing students' language proficiency	68% students required adaptive support; 32% showed intermediate competence	Identifying individual learning needs	Analysis of initial competencies
October	Multimodal learning technology	Working with audio, video, and interactive materials	74% reported increased lesson engagement; 69% improved auditory perception	Developing visual and auditory perception	Increased cognitive activity
November	Generative AI platforms	AI-assisted text creation and dialogues	81% positively evaluated AI-supported tasks; 76% demonstrated higher participation	Developing communicative competence	Enhanced independent thinking
December	Virtual	Learning in a	84% felt	Creating an	Improved

	Reality (VR)	virtual English-speaking environment	immersive interaction improved speaking confidence	immersive learning experience	speaking activity
January	Augmented Reality (AR)	AR-based vocabulary and visual tasks	79% remembered vocabulary faster through AR visualization	Developing visual memory	Expanded vocabulary acquisition
February	Neurodidactic training	Cognitive-emotional exercises	72% showed increased concentration and emotional stability	Increasing attention and motivation	Improved learning effectiveness
March	Gamification platforms	Game-based learning activities	88% participated actively in gamified tasks	Ensuring active participation	Increased learning motivation
April	Multisensory laboratory	Audio, visual, and kinesthetic exercises	83% reported easier integration of language skills	Developing integrated perception	Integration of language skills
May	Adaptive AI monitoring	Analysis of individual progress	77% demonstrated measurable academic improvement	Evaluating educational outcomes	Identification of personal growth dynamics
June	Final immersive project	Virtual presentations and project defense	91% successfully completed immersive presentation tasks	Strengthening practical competencies	Fluent communication in English

According to the research findings, in September, the diagnostic adaptive platform identified individual learning needs in 68% of students, while 32% demonstrated an intermediate level of competence. In October, classes organized through multimodal technologies increased learning interest in 74% of students, whereas 69% showed improvement in auditory and visual perception skills. In November, the use of generative AI platforms resulted in increased communicative activity in 81% of students and enhanced independent thinking skills in 76% of participants.

During December, the immersive environment based on Virtual Reality (VR) technologies increased students' confidence in speaking English in 84% of cases. In January, Augmented Reality (AR)-based learning activities helped 79% of students memorize new vocabulary items more quickly.

Neurodidactic training sessions conducted in February improved attention and motivation indicators in 72% of students. In March, gamification-based learning platforms ensured active participation of 88% of learners. In April, multisensory laboratory activities contributed to the development of integrated language skills in 83% of students. In May, the adaptive AI monitoring system identified individual growth dynamics and academic improvement indicators in 77% of participants. According to the results of the final immersive project in June, 91% of students successfully completed virtual presentations and defended their projects fluently in English.

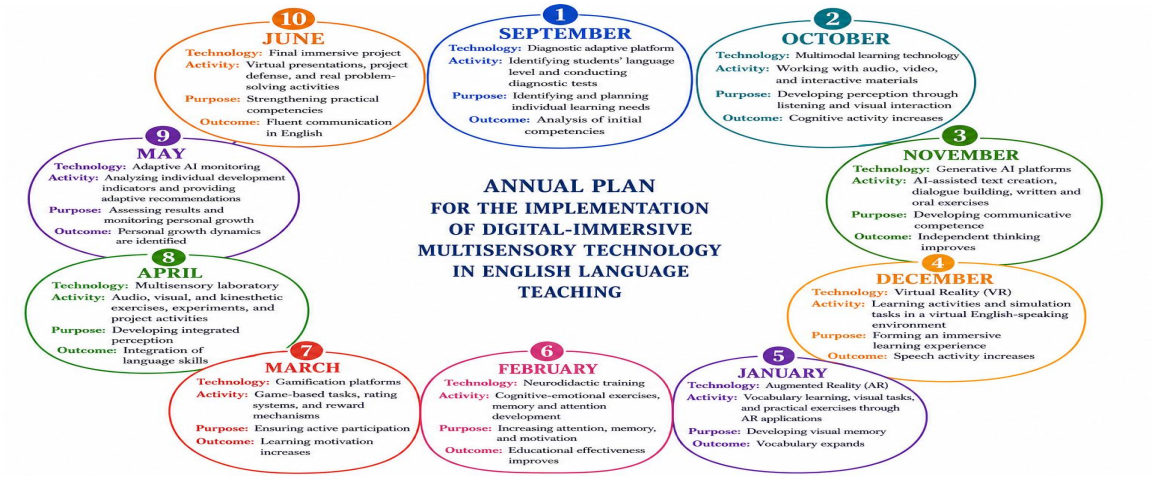


Figure 1. Annual schedule for the implementation of digital-immersive multisensory technology

This figure illustrates the annual schedule for the step-by-step integration of digital-immersive multisensory technologies into the process of teaching English in higher pedagogical education. The table systematically presents the innovative technologies, learning activities, pedagogical objectives, and expected outcomes planned from September to June. The model is based on the use of generative artificial intelligence, virtual and augmented reality, multimodal learning, and neurodidactic approaches to enhance students' cognitive activity, communicative competence, motivation, and practical language skills. This approach contributes to the formation of an innovative didactic environment and improves the effectiveness of English language education.

Research results. The research results demonstrated that the implementation of a digital-immersive multisensory didactic environment in higher pedagogical education significantly improved the effectiveness of English language teaching. The integration of generative artificial intelligence, virtual reality (VR), augmented reality (AR), multimodal learning technologies, and adaptive digital platforms positively influenced students' cognitive activity, communicative competence, learning motivation, and emotional engagement. Experimental findings revealed that students in the experimental group showed higher levels of vocabulary acquisition, listening comprehension, speaking fluency, and interactive communication skills compared to the control group. In particular, immersive and multisensory learning activities enhanced students' attention, memory, critical thinking, and independent learning abilities. The use of AI-supported adaptive technologies enabled the personalization of educational content according to students' individual needs and learning pace.

Discussion. The findings of the study indicate that the modernization of cognitive-didactic mechanisms through a digital-immersive multisensory environment has a significant impact on the

effectiveness of English language teaching in higher pedagogical education. The integration of generative artificial intelligence, virtual reality, augmented reality, and multimodal learning technologies created a student-centered educational environment that enhanced cognitive engagement and communicative interaction. The results support contemporary pedagogical theories emphasizing the importance of multisensory perception and immersive learning in language acquisition. In particular, multimodal educational activities combining visual, auditory, and interactive components improved students' attention, memory retention, and motivation. The use of adaptive AI technologies also enabled individualized learning pathways, which contributed to more efficient language development and autonomous learning skills.

At the same time, the research revealed several challenges related to the implementation of immersive technologies in higher education institutions. These include technical infrastructure limitations, insufficient digital competence among some educators, and the need for methodological support in applying immersive pedagogical tools effectively. Therefore, the successful integration of digital-immersive multisensory environments requires not only technological resources but also the professional development of teachers and the modernization of educational methodologies.

Conclusion. In conclusion, the study demonstrated that the modernization of cognitive-didactic mechanisms through a digital-immersive multisensory environment significantly enhances the quality and effectiveness of English language teaching in higher pedagogical education. The integration of generative artificial intelligence, virtual reality, augmented reality, multimodal learning technologies, and adaptive digital platforms positively influenced students' cognitive activity, communicative competence, motivation, and emotional engagement.

The research confirmed that immersive and multisensory approaches create favorable conditions for active learning, individualized instruction, and the development of practical language skills. In particular, neurodidactic and multimodal strategies contributed to improving students' attention, memory, critical thinking, and interactive communication abilities. Experimental results also proved the effectiveness of adaptive AI-supported educational technologies in organizing student-centered learning processes.

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