ABSTRACT

of the dissertation for the degree of Doctor of Philosophy (PhD) in the educational program 8D01503 – "Training of Computer Science Teachers"
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Research Topic: Methods of Teaching School Computer Science in English Based on Blended Learning Technology

Relevance of the Research Topic. Today, rapid changes and globalization processes present new challenges to the education system. A key factor in modern society's transition to a post-industrial stage is education focused on developing the ability to work in changing conditions and adapt to the demands of a new world.

According to the Concept for the Development of Preschool, Secondary, and Technical and Vocational Education in the Republic of Kazakhstan for 2023–2029, approved by Decree No. 249 of the Government of the Republic of Kazakhstan as of March 28, 2023, new directions in educational development are based on a model of pedagogical support for students. In this model, the teacher becomes a mentor who helps learners independently explore the world around them, unlock their potential, and acquire knowledge based on their individual interests and needs. One of the key trends in the educational process is the shift from traditional curricula toward preparing students for the future, including the development of global competencies.

To develop global competencies, it is essential to implement integrated approaches in curricula, utilize digital technologies and interactive methodologies, incorporate linguistic and cultural education, execute practical projects, and foster collaborative and value-based learning. Thus, the focus of educational programs on cultivating global competencies is a crucial aspect of ensuring modern educational content.

Within this framework, both international and domestic researchers—such as V.V. Davydov, M.P. Lapchik, V.S. Lednev, A.V. Mogilev, M.I. Ragulina, I.V. Robert, E.K. Henner, L.V. Bosova, V.V. Grinshkun, A.Yu. Uvarov, E.I. Bidaibekov, K.S. Abdiev, G.K. Nurgalieva, D.M. Dzhusubalieva, G.B. Kamalova, Zh.K. Nurbekova, A.I. Tazhygulova, K.M. Berkimbaev, A.E. Sagymbaeva, Z.S. Kazhiakparova, A.H. Davletova, M.U. Mukasheva, N.T. Oshanova, G.K. Nurmukhanbetova, A.B. Ibashova, and S.A. Nariman and others—have contributed to advancing the methodology of teaching computer science and applying modern educational technologies.

In the current context of educational development and the support of trilingual education policies, there is a growing need to teach computer science in English, as it is the dominant language in programming, information technology, and scientific research. This is supported by studies conducted by scholars such as Coyle D., Hood P., Marsh D., A.A. Verbitsky, D.K. Voronina, M.V. Martynova, E.B. Borunova, N.B. Simakova, S.I. Tambieva, I.V. Voronina, G. Kussainkyzy, Ida Dringo-Horvath**,** and others, which focus on interdisciplinary integration, including the merging of computer science and English language instruction.

Based on the studied works, it has been established that the CLIL (Content and Language Integrated Learning) methodology is employed in teaching subject content in English, integrating language acquisition with subject mastery and transforming these lessons into full-fledged subject classes conducted in a foreign language rather than conventional language instruction. However, the varying levels of English proficiency among students present significant challenges, including difficulties in comprehending instructional texts and assignments, reduced motivation due to the dual cognitive load of learning both subject matter and language, a widening learning gap among students, decreased classroom participation among less fluent learners, and increased teacher workload in managing diverse language levels—ultimately leading to unfair assessment outcomes for students with lower language proficiency.

To mitigate these issues, exploring the potential of blended learning technology is essential, as it facilitates flexible, self-paced learning tailored to individual needs and proficiency levels.

It is worth noting that the conceptualization of "blended learning" and the foundational principles of its organization were initially explored by international scholars such as Purnima Valiathan; Wilson D. & Smilanich E.; Curt Bonk; Garrison & Vaughan; Collis & Moonen; Tuncay & Uzunboylu; Hung & Chou; Wang Y., Han X., & Yang J., among others.

The research of these scholars, positions blended learning as one of the most effective tools for modernizing education systems, as it combines traditional teaching methods with modern information and communication technologies. Blended learning optimally integrates face-to-face and distance learning, mitigating their individual drawbacks while leveraging the strengths of each. This approach allows students to control the pace, place, and time of their learning, incorporates self-assessment elements, and enhances the process through online interaction with instructors.

The implementation of blended learning technology allows for the pre-distribution of instructional materials, enabling students to engage with the content at their own pace and achieve a deeper understanding of the subject matter. Furthermore, as the complexity of the computer science curriculum increases, certain topics become challenging to cover within a single lesson. In such cases, students can independently study theoretical material at home and then use classroom time to clarify questions and reinforce their understanding through practical exercises. This approach enhances the efficiency of the educational process and improves education quality.

However, despite the promising potential of this approach, the methodology for its application in teaching secondary school computer science in English—aimed at leveling students' language proficiency—remains understudied. Key challenges, such as adapting instructional materials, selecting appropriate digital tools, and organizing the learning process to accommodate varying language proficiency levels, require further scientific and methodological justification. Moreover, these issues highlight the necessity of integrating tailored educational content into computer science instruction in English. In this regard, the development of specialized learning materials, the provision of

methodological support, the implementation of modern technologies, and the creation of new educational resources further underscore the relevance of this research topic.

The integration of digital educational platforms and interactive tools within a blended learning framework enables the adaptation of the instructional process to students' individual needs. For instance, interactive exercises, video lectures, and automated assessments allow learners to engage with the material at their own pace, while teachers can monitor progress and provide differentiated support.

An analysis of the aforementioned issues revealed a lack of theoretical and methodological foundations to ensure effective instruction for students with varying language proficiency levels in the context of teaching computer science in English at Kazakhstani schools. This analysis further identified the following contradictions:

- between the objective necessity of implementing blended learning technology to facilitate successful mastery of computer science among students with diverse English proficiency levels and the insufficient body of scientific and methodological research on its practical application;
- between the growing demand for computer science instruction in English at the school level and students' inadequate language competence in mastering subject-specific terminology and concepts.

The need to address these contradictions determined the choice of the research topic: "Methodology for Teaching School Computer Science in English Based on Blended Learning Technology."

Research Objective - To provide theoretical and methodological justification for the effectiveness of blended learning technology in teaching school-level computer science in English, as well as to develop a methodology that enhances the quality of knowledge acquisition.

Object of Study - The process of teaching computer science in English to high school students.

Subject of Study - A methodology ensuring effective computer science instruction in English within a blended learning framework.

Research Hypothesis: If theoretical and methodological foundations for applying blended learning technology in high school English-medium computer science instruction are established, and an appropriate methodology with supporting tools is developed and implemented, then students will develop stronger independent learning skills, improve language competence in computer science terminology, achieve higher-quality knowledge and skills in computer science.

In accordance with the research objective and hypothesis, the following **objectives** were defined:

- to examine current approaches to teaching school-level computer science;
- to provide theoretical justification for the effectiveness of blended learning and CLIL (Content and Language Integrated Learning) technologies in English-medium computer science instruction;
- to develop a model for integrating subject content and linguistic competencies in computer science using blended learning and CLIL methodologies;

- to design a teaching methodology for the "Algorithms and Programming" module of the school computer science curriculum in English, based on blended learning technology, and to conduct a pedagogical experiment assessing its effectiveness.

The main idea of the study: Development of language competencies and improvement of the quality of subject knowledge based on the use of an integrated approach, digital technologies and interactive methods in the formation of global competencies is one of the main features of modern education. Integration of blended learning and CLIL technologies aimed at developing global competencies creates conditions for the educational process to meet modern requirements and increase the competitiveness of students. Accordingly, the use of blended learning methods in computer science in English based on scientific principles contributes to the formation of independent work skills in students, the development of language competencies, and the improvement of the quality of knowledge and skills in the field of computer science.

Research sources: Law of the Republic of Kazakhstan "On Education", Mandatory State Educational Standards for all levels, Concept of Development of Preschool, Secondary, Technical and Vocational Education of the Republic of Kazakhstan for 2023-2029, Messages of the President of the Republic of Kazakhstan to the People of Kazakhstan, scientific works of domestic and foreign researchers on teaching school computer science, educational electronic resources and scientific works and best practices of educator-researchers in the field of innovative learning technologies.

The research methods employed in this study encompassed both theoretical and empirical approaches, including theoretical analysis of psychological-pedagogical and scientific-methodological literature, analysis and synthesis of pedagogical practices, as well as modeling methods, pedagogical experimentation, survey questionnaires, interviews, and mathematical statistics - with the modeling method being specifically utilized to design computer science lessons incorporating blended learning and CLIL instructional technologies.

Methodological and Theoretical Foundations of the Research: This study is grounded in an interdisciplinary theoretical framework that integrates philosophical concepts and principles, including epistemological theories and scientific systemic approaches, with the legal foundations established by the Republic of Kazakhstan's Law "On Education" and related educational policies and programs. Pedagogically, it draws upon learner-centered instructional design, competency-based education, and activity-based developmental learning theories. The methodological foundation combines computer science education theory with contemporary digital transformation in education, while specifically examining innovative approaches including blended learning technologies and Content and Language Integrated Learning (CLIL) methodologies. This comprehensive framework enables a robust examination of the intersection between technological, pedagogical, and linguistic dimensions in computer science education.

Scientific Novelty of the Research:

- the study provides a comprehensive analysis of the content framework of the school computer science curriculum and currently employed teaching approaches, while also assessing the present state of computer science education.
- theoretical substantiation has been provided for the effectiveness of applying blended learning technology and CLIL (Content and Language Integrated Learning) methodologies in teaching computer science in English;
- an integration model has been developed combining subject content and language competencies in computer science education through the implementation of blended learning and CLIL technology;
- a teaching methodology has been created for the "Algorithms and Programming" section of the school computer science curriculum in English, based on blended learning technology.

The theoretical significance of the research lies in its justification of the necessity for blended learning approaches in school computer science education and the integration of subject knowledge with students' linguistic competencies within the context of digital transformation, including the clarification of fundamental principles and provisions of blended learning technology along with the development of a classification of implementation tools. The study specifically examines the distinctive characteristics of applying CLIL technology when teaching school-level computer science in English, develops methods for integrating disciplinary content with language competencies, and formulates both the content and instructional methodology for the "Algorithms and Programming" section of the English-medium computer science curriculum within blended learning environments.

The practical significance of the research lies in the creation of instructional materials and a task system for teaching computer science in English within a blended learning environment, including the development of an educational manual titled "Using CLIL Technology in Computer Science Instruction" and an information-educational platform that have been successfully implemented in actual teaching practice, with these resources being offered for use in general education schools as well as in teacher professional development programs.

Key propositions defended in the dissertation:

1. The analysis of the computer science curriculum structure and current teaching methodologies reveals the necessity to align educational content and pedagogical approaches with contemporary educational demands and technological advancements. This necessitates (a) systematic updating of computer science curricular content, (b) comprehensive evaluation of teaching method efficacy, and (c) development of flexible modern learning models targeting simultaneous development of subject-specific and linguistic competencies.
2. The integration principle of blended learning and CLIL methodologies in English-medium computer science instruction constitutes a comprehensive pedagogical framework. This approach simultaneously facilitates (1) subject knowledge acquisition

and (2) language skill development, requiring careful coordination of learners' cognitive, linguistic, and digital competencies within the instructional design.

3. The proposed integrative model for combined subject-language learning through blended formats represents a methodological framework for synergistically developing computer science knowledge and English proficiency in upper-secondary education. This model structures the learning process through unified content-language units, enabling balanced development of (i) computational thinking and (ii) language competencies.

4. The blended learning-based methodology for teaching the "Algorithms and Programming" unit in English demonstrates effective integrated acquisition of subject matter and language skills. Pedagogical experimentation and empirical research confirm the methodology's efficacy in ensuring high-quality content mastery, efficient learning processes and foundation for innovative pedagogical solutions combining subject and language learning

The author's original contribution to this research consists of establishing the theoretical and methodological foundations for improving educational quality and developing students' language competencies through the integration of subject knowledge (computer science) and language skills (English) in a blended learning environment; practical implementation of this methodology in school-level computer science instruction; and conducting experimental studies, analyzing results, and validating the scientific hypothesis through empirical evidence.

The validity and reliability of the research findings are substantiated by: (1) a comprehensive review of scientific, theoretical, and methodological literature forming the study's theoretical foundation; (2) application of research methods specifically aligned with the study's objectives and subject matter; (3) critical analysis of diverse approaches to teaching computer science in English within blended learning environments; (4) utilization of statistical data processing methods; and (5) consistent correspondence between experimental results and the original research hypotheses - collectively demonstrating methodological rigor throughout all stages of investigation.

Validation of Research Findings: The main provisions and findings of the study were presented and discussed at the following international scientific and practical conferences: *"Current Issues of Modern Science – 2023"* (Almaty, 2023), *"VII World Congress of Mathematicians of the Turkic World"* (Turkestan, 2023), *"Research World International Conference"* (Prague, 2024), *"European Research Materials"* (Amsterdam, 2024), and *"Modern Education: Experience, Challenges, and Prospects"* (Almaty, 2024). Additionally, the results were reviewed during academic and methodological seminars held by the department and faculty, as well as during the postdoctoral research conducted within the framework of the grant-funded project AP19175370 *"Development of an Information and Educational Environment with Gamification Elements for Implementing Blended Learning in Computer Science at Secondary School Level"* for the period 2023–2025.

Publications Based on the Research Results: A total of 13 publications have been produced from the dissertation research, including: 2 articles in international peer-

reviewed journals indexed in the Scopus database; 4 articles in scientific journals recommended by the Committee for Quality Assurance in the Sphere of Science and Higher Education of the Republic of Kazakhstan; 3 articles in international scientific and practical conferences held abroad; 2 articles presented at national-level international conferences; 1 certificate of authorship; and 1 educational and methodological manual.

Research Base: The experimental work was conducted at the educational institution Nazarbayev Intellectual School of Physics and Mathematics in Shymkent, as well as at the Municipal State Institution "Specialized Boarding School No. 2 with Trilingual Instruction" under the Department of Education of the city of Shymkent.
Research Stages: The study was carried out in three stages.
At the first stage (2019–2020), a comprehensive review of scientific, methodological, and pedagogical literature, as well as online resources related to the research topic, was conducted. The ideas presented in these sources were analyzed to determine the current state of approaches to teaching computer science in the context of digital transformation. Questionnaire items for the diagnostic (ascertaining) experiment were refined and analyzed. Materials were collected on both domestic and international research and practices related to blended learning and teaching computer science in English. Additionally, an analysis of the computer science curriculum and educational standards was conducted, along with relevant theoretical investigations.

Second Stage (2020–2022): identified the specific characteristics of applying the CLIL methodology to teaching school-level computer science in English. It established methods for integrating subject content with language competencies, along with developing instructional materials and tools for the "Algorithms and Programming" section of the English-medium computer science curriculum within blended learning environments. Key outputs included the creation of an educational manual titled *Using CLIL Technology in Computer Science Instruction*, an information-educational platform, theoretical materials, a task system for English-medium computer science teaching, and a finalized methodology for the "Algorithmization and Programming" unit - all validated through a formative experiment.

Third Stage (2022–2024): involved conducting a assessment experiment to evaluate the efficacy of the developed methodology, followed by comprehensive data analysis. This stage included synthesizing research findings from the implemented teaching approach, refining both theoretical frameworks and experimental materials, and formulating conclusive recommendations and practical implications.

Structure of the Dissertation: The dissertation comprises an introduction, two main chapters, a conclusion, a bibliography, and appendices.

The introduction substantiates the study's relevance, emphasizing the necessity of blended learning and CLIL technology for effective computer science instruction among students with varying English proficiency levels. It outlines the research objectives, defines the study's scope and focus, and enumerates specific tasks. The section presents the working hypothesis, highlights the scientific novelty, and states the key propositions defended in the dissertation. Additionally, it details the research stages, including

theoretical analysis, methodology development, experimental implementation, and data processing.

Chapter one explores the key processes of informatization, computerization, and digitalization. It analyzes the evolution of the content of the school computer science curriculum and contemporary approaches to its instruction. The chapter provides an overview of the concepts, models, and principles of blended learning, a classification of tools for its implementation, and the potential of this approach for teaching computer science. It also examines the theoretical foundations of the CLIL (Content and Language Integrated Learning) methodology, its specific application in preparing high school students to study the subject in English, and offers practical recommendations for planning and conducting CLIL-based lessons.

Chapter two presents a model for integrating subject content and language competencies through the use of blended learning and CLIL technologies. It outlines the content of the "Algorithms and Programming" section of the computer science curriculum in English and provides task samples for each topic. The methodology for teaching this section in a blended format is described in detail, along with data from the experimental validation. The chapter reviews the stages of the pedagogical experiment and provides a description of the educational institutions where it was conducted. Criteria for evaluating the effectiveness of the proposed methodology are defined, and the results of the study are analyzed. These results confirm the working hypothesis and reveal both quantitative and qualitative improvements, demonstrating the positive impact of the methodology on the educational process.

The conclusion summarizes the outcomes of the scientific and pedagogical research, formulates the main theoretical and practical findings, and highlights the scientific significance and potential applications of the obtained results.

The list of references includes 151 sources encompassing scientific publications, regulatory documents, and other materials utilized throughout the research process.

The appendices include official implementation reports of the developed methodology, certificates of authorship for the created information and educational environments, as well as supplementary materials such as questionnaires, sample exercises, and statistical data.