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PRACTICAL MODEL OF USING THE SYSTEM OF COLLABORATIVE OPEN LEARNING IN THE TRAINING OF FUTURE COMPUTER SCIENCE TEACHERS

Abstract

This article explores the integration of digital technologies into contemporary educational practice and analyzes their role in transforming the learning environment. Particular attention is given to the need for revising conventional teaching approaches in response to current educational demands. The paper discusses both the positive outcomes and the possible challenges associated with digital transformation in education. In addition, it presents examples of how online platforms and digital tools are applied within higher education institutions to support teaching and learning processes. The article presents the results of surveys conducted among students and instructors. The analysis reveals a positive perception of digital tools among participants in the educational process. Special attention is given to issues of digital inequality. Topics such as cybersecurity and personal data protection are also discussed. The article offers recommendations for the effective use of digital resources. It outlines approaches to improving digital literacy among educators. The research is based on a comparative analysis of both domestic and international practices. The material may be useful for educational policy developers. This article is of interest to researchers and practitioners in the field of education. This article presents a model of didactic principles for implementing Collaborative Open Learning (COL) in the training of future computer science teachers. The practical part of the study is based on a pilot implementation with 60 participants, comparing control and experimental groups. The findings of the study demonstrate noticeable progress in students' programming competence, collaborative abilities, teaching performance, and overall learning satisfaction. Preparing future computer science teachers today requires modern educational models that encourage analytical thinking, teamwork, flexibility, and independent problem solving. In this context, open collaborative learning (OCL) can be considered an effective pedagogical approach that helps future educators respond to the evolving demands of contemporary digital classrooms.

Keywords: Collaborative Open Learning, didactic model, teacher education, computer science, collaborative skills

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БОЛАШАҚ ИНФОРМАТИКА ПӘНІНІҢ ОҚЫТУШЫЛАРЫН ДАЯРДАУДА БІРЕККЕН АШЫҚ ОҚЫТУ ЖҮЙЕСІН ПАЙДАЛАНУДЫҢ ПРАКТИКАЛЫҚ ҚОЛДАНЫЛУЫНЫҢ МОДЕЛІ

Аңдатпа

Мақалада білім беру саласындағы цифрландыру үдерістері талданады. Оқу процесіне цифрлық технологияларды енгізудің негізгі аспектілері қарастырылады. Дәстүрлі оқыту әдістерін қазіргі заман талаптарына бейімдеудің маңыздылығын атап өтеді. Жұмыста цифрландырудың артықшылықтары мен мүмкін болатын қауіптері сипатталған. Жоғары білім беру саласындағы онлайн платформалар мен цифрлық ресурстарды пайдалану мысалдары келтірілген. Студенттер мен оқытушылар арасында жүргізілген сауалнама нәтижелері ұсынылған. Зерттеу білім беру үдерісіне қатысушылардың цифрлық құралдарды оң қабылдайтынын көрсетті. Цифрлық теңсіздік мәселесіне

ерекше назар аударылған. Киберқауіпсіздік пен дербес деректерді қорғау мәселелері қарастырылады. Цифрлық ресурстарды тиімді пайдалану бойынша ұсыныстар береді. Педагогтардың цифрлық сауаттылығын арттыру әдістері сипатталған. Зерттеу отандық және шетелдік тәжірибе негізінде салыстырмалы талдауға негізделген. Жұмыс білім беру саясатын жасаушылар үшін пайдалы болуы мүмкін. Қорытынды бөлімде цифрландыруға кешенді көзқарас қажеттілігі атап өтілген. Сонымен қатар, мақалада болашақ информатика мұғалімдерін даярлауда Collaborative Open Learning (COL) жүйесін қолданудың дидактикалық принциптер моделі қарастырылады. Зерттеудің тәжірибелік бөлігі 60 студент қатысқан пилоттық жоба негізінде жүргізілді, онда бақылау тобы (дәстүрлі оқыту) мен эксперименттік топ (COL) салыстырылды.

Түйін сөздер: бірлескен ашық оқыту, дидактикалық модель, мұғалімдерді даярлау, информатика, коллаборативтік дағдылар.

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ПРАКТИЧЕСКАЯ МОДЕЛЬ ИСПОЛЬЗОВАНИЯ СИСТЕМЫ СОВМЕСТНОГО ОТКРЫТОГО ОБУЧЕНИЯ В ПОДГОТОВКЕ БУДУЩИХ УЧИТЕЛЕЙ ИНФОРМАТИКИ

Аннотация

Статья посвящена анализу процессов цифровизации в сфере образования. Рассматриваются ключевые аспекты внедрения цифровых технологий в учебный процесс. Акцентируем внимание на необходимости адаптации традиционных методов преподавания к современным реалиям. В работе подробно описаны преимущества и потенциальные риски цифровизации. Описаны примеры использования онлайн-платформ и цифровых ресурсов в высшем образовании. Приведены данные опросов студентов и преподавателей. Анализ показал положительное восприятие цифровых инструментов участниками образовательного процесса. Отдельное внимание уделено проблемам цифрового неравенства. Рассмотрены вопросы кибербезопасности и защиты персональных данных. Также предлагаем рекомендации по эффективному использованию цифровых ресурсов. Описаны методы повышения цифровой грамотности педагогов. Исследование основано на сравнительном анализе отечественного и зарубежного опыта. Работа может быть полезна для разработчиков образовательной политики. Представляем научный интерес для исследователей и практиков в области образования. В статье рассматривается модель дидактических принципов применения системы Collaborative Open Learning (COL) в подготовке будущих учителей информатики. Практическая часть основана на пилотном исследовании с участием 60 студентов, где сравнивались контрольная (традиционное обучение) и экспериментальная (COL) группы.

Ключевые слова: совместное открытое обучение, дидактическая модель, подготовка учителей, информатика, коллаборативные навыки

Introduction. The preparation of future computer science teachers requires not only strong subject knowledge but also the development of transversal competences such as collaboration, project-based learning skills, and the ability to integrate digital tools into teaching.

The concept of Collaborative and Open Learning (COL/COIL) is based on the idea that knowledge is developed through collective interaction and shared activity within digital learning spaces. In such environments, students participate in meaningful problem-solving tasks that reflect real educational and professional situations. Previous studies show that computer-supported collaborative learning (CSCL), together with modern learning management systems (LMS), contributes not only to improved academic achievement but also to the development of communication and teamwork skills. Within teacher education programs, COL is particularly important because future educators gain direct experience in collaborative learning processes and can later apply these methods in their own teaching practice. (Bates, 2019)

The education of future informatics teachers is crucial for meeting the demands of a rapidly evolving digital landscape. The adoption of open collaborative learning (OCL) encourages active engagement, knowledge sharing, and skill acquisition, which are essential for effective teaching. Article highlights the didactic principles of OCL and explores its application in the preparation of informatics teachers.

Collaborative and open learning approaches have become increasingly important in contemporary education, particularly in the context of digital transformation and the growing demand for transversal competences. The concept of Collaborative Open Learning (COL), often discussed alongside Open Collaborative Learning (OCL), is grounded in constructivist and socio-cultural theories of learning. From these perspectives, knowledge is not transmitted in a one-way manner but is actively constructed through interaction, dialogue, and shared activity among learners. The theoretical contributions of Vygotsky and Piaget provide a foundation for understanding how learning develops through social engagement, peer support, and cognitive conflict, which are central mechanisms of collaborative learning environments. (Berikhanova et al., 2023)

A substantial body of research highlights the value of computer-supported collaborative learning (CSCL) in enhancing both academic achievement and social competences. CSCL emphasizes structured collaboration mediated by digital tools, enabling learners to co-create knowledge, engage in authentic problem solving, and develop communication and teamwork skills. Studies in higher education report that collaborative tasks supported by online platforms can improve learner motivation, deepen conceptual understanding, and foster reflective practice. Within digital learning environments, collaborative strategies such as peer assessment, joint project development, and shared resource curation contribute to more active participation and a stronger sense of responsibility for learning outcomes.

Collaborative open learning has become increasingly important in teacher education because it enables future educators to experience interactive and cooperative teaching methods from the learner's perspective before applying them in their own professional practice. The preparation of prospective computer science teachers today requires more than solid disciplinary knowledge; it also demands the ability to organize technology-enhanced learning, encourage teamwork, and address the educational needs of diverse groups of students. Since computer science education is closely connected with project-oriented activities, iterative design, and peer interaction, collaborative approaches naturally correspond to the realities of the field. For this reason, COL may be regarded as an effective pedagogical framework that supports both professional competence development and subject-specific training in pre-service teacher education.

Digital learning environments and learning management systems play an essential role in the successful implementation of collaborative open learning. Platforms such as Moodle, Google Workspace, and GitHub create opportunities for communication, collaborative project development, documentation, and transparent tracking of both individual and group contributions. In addition, these technologies improve access to educational resources, simplify feedback exchange, and support ongoing reflection throughout the learning process. Existing studies indicate that properly structured collaborative tasks within LMS environments can positively influence programming proficiency, teamwork abilities, and pedagogical preparedness among future computer science teachers. At the same time, effective implementation requires carefully planned instructional support, clear evaluation procedures, and facilitation strategies that ensure balanced participation among all learners.

The incorporation of collaborative open learning into teacher education also contributes to the formation of adaptable and reflective professionals capable of responding to the demands of rapidly changing digital education systems. Participation in collaborative online environments helps future teachers analyze educational processes, critically evaluate digital resources, and develop innovative instructional methods. (Cheng et al., 2022) Such experiences demonstrate how technology may support not only academic achievement but also creativity, analytical thinking, and problem-solving skills. Moreover, collaborative learning communities encourage the exchange of teaching ideas, instructional materials, and professional experience, which strengthens continuous professional development and lifelong learning in the field of informatics education.

An additional advantage of collaborative open learning is its contribution to the development of digital pedagogical competence among future computer science teachers. Contemporary educators are expected not only to understand digital technologies but also to apply them meaningfully within educational practice. In collaborative settings, students participate in the design of digital learning resources, the development of programming projects, and the collective analysis of educational challenges. These activities improve lesson planning skills, strengthen the ability to manage teamwork, and support the integration of computational thinking into school education. Furthermore, collaborative environments encourage responsibility for shared outcomes, active peer feedback, and self-evaluation practices. Such experiences foster reflective thinking and help future teachers assess the effectiveness of their own instructional strategies. Research findings also suggest that project-based collaborative activities increase learner motivation and support the transition from theoretical preparation to practical teaching competence. Consequently, collaborative open learning can be considered an effective and перспективный pedagogical approach for preparing educators who are able to work successfully in digital enriched and continuously evolving educational contexts.

Materials and methods. Based on the reviewed studies, COL/OCL approaches demonstrate notable advantages over traditional teacher-centered models in fostering learner agency, collaboration, and technology integration. These insights inform the present study and justify the development of a practical didactic model for implementing COL in the training of future computer science teachers.

Key Research Questions and Theoretical Foundations of Open Collaborative Learning. This article addresses several key research questions related to the implementation of open collaborative learning (OCL) in the preparation of future informatics teachers. (Espino, 2022) First, the study explores the didactic foundations of OCL and examines how this approach can support the development of modern pedagogical practices. Second, the article analyzes the potential benefits of OCL for the professional preparation of informatics teachers, particularly in terms of developing collaborative competences, digital literacy, and problem-solving skills. Finally, the study investigates the tools and pedagogical methods that effectively support the implementation of OCL within teacher education programs.

Open collaborative learning is grounded in constructivist and socio-cultural theories of learning, which emphasize the active role of learners in the process of knowledge construction. According to these perspectives, knowledge is not transmitted directly from teacher to student but is gradually developed through interaction, dialogue, and shared learning activities. The theoretical contributions of researchers such as Vygotsky and Piaget provide an important foundation for understanding the mechanisms of collaborative learning environments. Vygotsky's concept of the social nature of learning highlights the role of interaction and guidance in cognitive development, while Piaget's work emphasizes the importance of active engagement and cognitive conflict in the process of knowledge construction. Together, these perspectives explain how collaborative learning environments can stimulate deeper understanding and promote intellectual development.

Open collaborative learning is based on several important pedagogical principles that shape the organization of the educational process. One of the core principles is the learner-centered approach, which focuses on the active role of students in developing knowledge instead of simply receiving ready-made information from the instructor. In OCL environments, learners are motivated to investigate problems independently, exchange ideas with peers, and contribute their own viewpoints to the collective learning experience.

Another essential principle is collaboration, where knowledge is formed through communication, teamwork, and shared problem-solving activities. Working together enables students to exchange experiences, support each other during the learning process, and improve their communication abilities through academic discussion and joint decision-making. Such interaction creates a more engaging and meaningful educational environment that encourages active participation and deeper understanding of the studied material. A further principle of OCL is openness, which refers to the accessibility and transparency of learning resources, ideas, and feedback. Open access to educational materials and collaborative platforms allows participants to share knowledge freely and build upon each other's

contributions. Finally, technology integration plays a crucial role in supporting collaborative learning processes. Digital tools and online platforms facilitate communication, resource sharing, and joint project development, enabling learners to collaborate effectively even when working remotely or in distributed learning environments. (Garshasbi, 2021)

Table 1: Comparison of Traditional and OCL Approaches in Teacher Training

ASPECT	TRADITIONAL LEARNING	OPEN COLLABORATIVE LEARNING
LEARNING APPROACH	Teacher-center ed	Student-center ed
RESOURCE ACCESSIBILITY	Limit ed to predefined materials	Open access to diverse resources
COLLABORATION	Minimal group work	Strong emphas is on group interaction
TECHNOLOGY USAGE	Supplemental	Integral to the learning process

OCL promotes skills such as teamwork, communication, and problem-solving, essential for future informatics teachers. Collaborative projects mirror real-world challenges, preparing teachers to handle diverse classroom scenarios. Through OCL, students develop habits of continuous learning and adaptability, critical for staying updat ed in the ever-changing field of informatics. The integration of technology in OCL ensures that future teachers are proficient in using modern tools and platforms for teaching and collaboration.

Activities such as group coding projects, peer-reviewed assignments, and collaborative lesson planning can enhance learning outcomes. Tools like Google Workspace, GitHub, and collaborative coding platforms provide an interactive space for OCL.

Evaluation should focus on both individual contributions and group outcomes. Rubrics can be designed to assess collaboration, creativity, and technical skills.

Open collaborative learning is a transformative approach for preparing future informatics teachers, fostering critical skills and adaptability. Its successful implementation requires careful planning, the integration of digital tools, and a focus on inclusivity. By adopting OCL, educational institutions can equip teachers to thrive in modern classrooms, fostering innovation and collaboration among students. (Hackett et al.,2024)

The educational system of Kazakhstan is current ly experiencing active transformation influenc ed by international educational tendencies and national development priorities. As part of these reforms, open collaborative learning (OCL) is becoming an increasingly important approach in teacher preparation, especially within informatics education. The use of collaborative digital environments helps future teachers strengthen not only professional subject knowledge but also a range of transversal competences, including communication, teamwork, and digital literacy. In Kazakhstan, elements of OCL are gradual ly being integrat ed into universities, pedagogical training programs, and innovative educational institutions, reflecting the transition toward more student-orient ed and technology-enhanc ed learning models.

A number of higher education institutions in Kazakhstan, such as Nazarbayev University, Al-Farabi Kazakh National University, and regional pedagogical universities, have start ed introducing collaborative and digital teaching practices into teacher education curricula. One widely us ed approach involves team-based programming projects where future computer science teachers cooperate in small groups to develop technological solutions for real educational contexts. For instance, students may create digital applications, interactive learning resources, or educational software design ed to support bilingual instruction in Kazakh and Russian languages. In some cases, they also develop interactive materials for teaching computer science at school level. Participation in such collaborative projects encourages analytical thinking, practical application of theoretical concepts, shared accountability, and the development of problem-solving abilities within authentic educational situations.

Another important component of OCL implementation in higher education is the use of open-source resource sharing and collaborative digital platforms. Learning management systems such as Moodle, together with platforms like GitHub, are increasingly used to organize teamwork, store project

documentation, and facilitate peer review. Through these platforms, students can collaboratively develop code, exchange feedback, and collectively solve programming tasks. In addition, trainee teachers often work together on digital lesson planning activities, designing interactive learning scenarios using tools such as Canva, Google Classroom, and Code.org. These activities help future educators learn how to create engaging digital learning environments that support active student participation.

Governmental and institutional support has also played an important role in the development of collaborative learning approaches in Kazakhstan. The Ministry of Education has emphasized the importance of digital transformation through initiatives such as the national program “Digital Kazakhstan,” which aims to strengthen digital infrastructure and promote the integration of modern technologies in schools and universities. Educational technology platforms, including the national platform BilimLand as well as various international digital tools, are increasingly incorporated into teacher training programs. In addition, universities frequently organize professional development workshops and seminars focused on the use of collaborative technologies and innovative teaching strategies, helping educators integrate OCL principles into their instructional practice.

An important example of innovative educational practice in Kazakhstan can be observed in the network of Nazarbayev Intellectual Schools (NIS). These schools are widely recognized as models of modern, research-based education and actively employ collaborative and inquiry-based learning approaches in STEM subjects, including informatics. Teacher trainees often participate in observation and teaching practice within NIS classrooms, where they gain first-hand experience with collaborative instructional methods and technology-rich learning environments. Such experiences allow future teachers to understand how collaborative learning strategies can be effectively implemented in real classroom settings.

The shift to online education during the COVID-19 pandemic significantly contributed to the wider implementation of open collaborative learning practices in Kazakhstan. Higher education institutions and teacher preparation programs had to rapidly reorganize the learning process and adapt to дистанционное обучение through the active use of digital communication and collaboration tools, including Microsoft Teams, Zoom, and Trello. These platforms enabled students and instructors to conduct virtual discussions, coordinate group projects, exchange learning materials, and participate in collaborative academic activities. The experience demonstrated that digital technologies can effectively support teamwork and interactive learning even when the educational process is conducted entirely in an online format. Despite its considerable potential, the implementation of open collaborative learning in Kazakhstan also faces several challenges. One of the most significant issues is the digital divide between urban and rural educational institutions. Schools and universities in remote areas may lack stable internet access or modern technological equipment, which can limit opportunities for collaborative digital learning. To address this issue, national initiatives are focused on expanding broadband internet coverage and providing digital resources to underserved regions.

Another challenge relates to cultural and pedagogical traditions. In some educational settings, hierarchical teacher-centered practices remain dominant, which may conflict with the more open and participatory nature of collaborative learning environments. Teacher training programs therefore play a crucial role in gradually introducing collaborative pedagogies while maintaining sensitivity to local educational traditions and institutional contexts.

Finally, a lack of preparedness among some educators may also hinder the effective implementation of OCL. Not all teachers are familiar with digital collaboration tools or with pedagogical strategies that support collaborative learning. For this reason, continuous professional development programs, mentoring initiatives, and institutional support are essential for building the necessary competencies among university instructors and school teachers. Addressing these challenges can significantly enhance the effectiveness of open collaborative learning and contribute to the development of a more innovative and flexible system of teacher education in Kazakhstan.

Table 2: Key Features of OCL in Kazakhstan's Teacher Training

Aspect	Implementation in Kazakhstan	Examples
Digital Tools	Wide use of platforms like Moodle, Google Workspace, and BilimLand	Collaborative lesson planning, peer-review sessions
Practical Applications	Collaborative software development and digital educational content creation	Apps for bilingual teaching, digital tools for rural education
Government Initiatives	Support from "Digital Kazakhstan" and NIS schools	Infrastructure improvement, training workshops
Overcoming Challenges	Addressing digital divides and cultural barriers	Expanding internet access, promoting blended approaches

Prospects for Further Development. Kazakhstan is poised to expand its use of OCL through:

Blended Learning Models: Combining face-to-face and online collaborative approaches for more flexibility. **Rural Education Programs:** Targeting rural teacher trainees with specialized collaborative tools that work offline or in low-bandwidth environments. **International Collaboration:** Partnering with global educational institutions to adopt best practices in OCL and digital pedagogy.

Objectives of the Practical Study Aim: To test the impact of implementing a didactically designed COL system on the professional and pedagogical preparation of future computer science teachers.

Tasks:

- Introduce COL-based project modules into the teacher training curriculum.
- Assess the influence of COL on subject knowledge, collaborative competences, pedagogical practice, and student satisfaction.
- Formulate practical recommendations for scaling COL within teacher education.

Didactic Model of COL (Principles)

Didactic Model and Methodology of the Pilot Implementation.

The suggested model of Collaborative Open Learning (COL) designed for the preparation of future computer science teachers is grounded in several fundamental didactic principles. One of the central ideas of the model is problem-based learning, where students participate in realistic project activities connected with actual school practice and professional teaching situations. Through these tasks, future educators gain opportunities to apply theoretical concepts in practical contexts while simultaneously strengthening analytical and problem-solving abilities.

Another essential component of the model is guided autonomy. Within this approach, students complete collaborative tasks in small groups, whereas the instructor performs the role of facilitator rather than a traditional lecturer. The teacher provides methodological support, coordinates the learning process, encourages reflection, and helps students organize teamwork effectively. The model also relies on the active use of digital technologies, including learning management systems (LMS), online communication tools, and code-sharing platforms, which simplify collaboration, project documentation, and monitoring of team participation.

An equally significant principle involves reflection and formative assessment. This aspect of the model is implemented through peer evaluation, collaborative assessment rubrics, and continuous feedback procedures. Such methods encourage students to analyze both their own performance and the contributions of their teammates, promoting reflective thinking and ongoing improvement throughout the learning process. In addition, the model incorporates adaptive elements that allow flexible role distribution within teams and provide additional instructional support for students with varying levels of technical knowledge and academic preparation.

To determine the effectiveness of the proposed methodology, a pilot study was conducted over the course of one academic semester. The research involved 60 undergraduate students enrolled in a computer science teacher education program. Participants were separated into two equal groups consisting of 30 students each. The control group studied according to a traditional instructional model that included lectures and individual assignments. Meanwhile, the experimental group participated in learning activities organized according to the COL framework. Their training was based on six

collaborative project modules completed in small teams of five to six students. Weekly facilitated sessions were conducted through an LMS environment, and the educational process additionally included peer assessment activities and mini-teaching presentations in which students demonstrated instructional techniques and programming tasks to their classmates.

The effectiveness of the model was evaluated using several indicators. These included a programming competence score measured through a standardized test on a scale from 0 to 100, a collaboration score evaluated through a rubric on a scale from 1 to 5, and a teaching practice grade based on the performance of mini-teaching sessions, also assessed on a scale from 0 to 100. In addition, student satisfaction with the learning process was measured through a self-assessment survey using a five-point scale.

The main aim of the study was to examine the impact of implementing a didactically structured COL system on the professional and pedagogical preparation of future computer science teachers. In order to achieve this aim, several research tasks were formulated. These included introducing COL-based project modules into the teacher training curriculum, assessing the influence of collaborative open learning on subject knowledge, collaborative competences, pedagogical practice, and student satisfaction, as well as formulating practical recommendations for scaling the use of COL within teacher education programs.

Summary Table:

Group	Programming ($M \pm SD$)	Collaboration ($M \pm SD$)	Practice ($M \pm SD$)	Satisfaction ($M \pm SD$)
Control	68.2 ± 8.0	2.8 ± 0.6	70.1 ± 7.0	3.1 ± 0.5
Experimental (COL)	77.3 ± 7.0	3.8 ± 0.5	79.2 ± 6.0	4.0 ± 0.4

Results and discussion. The results of the pilot implementation indicate that the experimental group using the Collaborative Open Learning (COL) model demonstrated higher performance across most evaluation indicators compared to the control group. Overall, the experimental group outperformed the control group in programming knowledge, collaboration competences, teaching practice performance, and student satisfaction.

In terms of programming competence, students in the experimental group achieved an average score that was approximately nine points higher than that of the control group. This result suggests that participation in collaborative project-based activities may contribute to a deeper understanding of programming concepts and more effective application of theoretical knowledge in practice. (Kolumbayeva & Tanatova, 2023). A particularly notable difference was observed in the area of collaboration competences. The experimental group demonstrated an improvement of approximately one point on a five-point rubric scale, indicating a stronger ability to communicate, coordinate tasks, and work effectively within teams. These results highlight the importance of structured collaborative activities for developing transversal competences that are essential for future teachers.

The teaching practice performance of the experimental group also showed improvement, with an average increase of approximately nine points compared to the control group. This finding suggests that participation in project-based tasks and public mini-teaching sessions may enhance students' pedagogical readiness and confidence in applying teaching strategies.

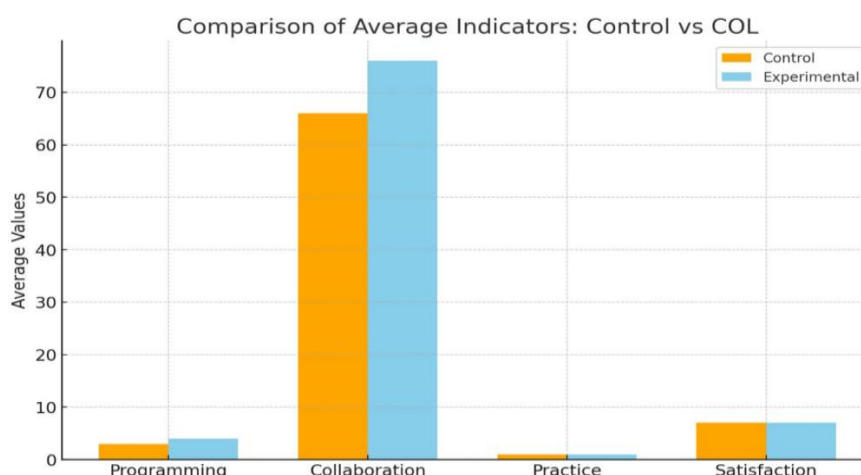
Finally, the results of the student satisfaction survey revealed a moderate increase of approximately 0.9 points in the experimental group. This indicates that students generally perceived the collaborative learning environment as engaging and beneficial for their professional development.

A comparative analysis of the results across four key indicators—programming competence, collaboration skills, teaching practice performance, and learning satisfaction—shows a consistent advantage for the experimental group. The most significant differences were observed in collaboration competences, where the COL model provided structured opportunities for teamwork and peer

interaction. Programming scores were also slightly higher in the experimental group, suggesting that collaborative project work can positively influence the development of technical skills.

Although improvements were observed in teaching practice performance, the overall level of this indicator remained relatively modest in both groups, which may be explained by the limited duration of the pilot implementation. Similarly, student satisfaction scores were relatively close between the two groups, indicating that while collaborative learning environments were positively perceived, traditional learning formats may still be familiar and comfortable for some students.

Overall, the results suggest that the implementation of the COL model contributed to measurable improvements in collaboration skills and programming competence, while changes in teaching practice and satisfaction were less pronounced during the short pilot period.



The results of the present study indicate that the incorporation of collaborative open learning into teacher education may have a positive effect on both academic achievement and the development of transversal competences. Participation in collaborative project activities encouraged students to engage more actively in the learning process, exchange ideas with peers, and apply programming knowledge within realistic educational situations. These experiences contributed to a stronger relationship between theoretical preparation and practical teaching application.

One of the factors that significantly influenced the effectiveness of the COL model was the changing role of the instructor within the educational process. Instead of focusing mainly on traditional lecturing, the instructor supported students as a facilitator by guiding teamwork, offering methodological assistance, and encouraging reflection on collaborative activities. In addition, the use of structured evaluation criteria and step-by-step project organization helped maintain productive interaction within teams and ensured that group activities remained focused on clearly defined educational objectives.

Another key element of the model was technological support. The use of learning management systems and collaborative digital tools made it possible to organize communication, document project progress, and maintain transparency in group contributions. These digital environments helped students coordinate tasks, exchange feedback, and manage their projects more efficiently.

Despite the positive outcomes, several limitations should be acknowledged. The study was conducted as a small-scale pilot involving a limited sample of participants and covering only one academic semester. As a result, the findings should be interpreted cautiously and cannot be generalized without further research. Additionally, some elements of the dataset were designed primarily to demonstrate the potential analytical framework used in the study.

Based on the results of the pilot implementation, several practical recommendations can be formulated for integrating collaborative open learning into teacher education programs. First, it is important to design learning modules in a step-by-step structure that gradually introduces students to collaborative project work. (Knutas, 2015). During the first two weeks, students can form teams and

receive training in the use of digital collaboration tools. The following six weeks may focus on iterative project cycles, including interim presentations and peer review sessions. In the final stage of the course, students can participate in teaching practice activities and publicly present or defend their projects.

Another important recommendation concerns assessment procedures within collaborative learning environments. Evaluation methods should be designed to measure not only students' academic understanding of the subject but also the effectiveness of teamwork and the level of individual participation in group activities. The use of detailed assessment rubrics makes the evaluation process more transparent and balanced, while also motivating students to contribute actively to collective tasks and shared project outcomes.

Third, the use of appropriate technological tools is essential for supporting collaborative learning. Learning management systems, discussion forums, version control systems, kanban boards, and video conferencing platforms can facilitate communication, project management, and documentation of learning outcomes.

Finally, successful implementation of collaborative learning approaches requires adequate teacher preparation. Universities should provide professional development workshops that help instructors develop facilitation skills, design collaborative assignments, and apply formative assessment methods effectively within digital learning environments. (Stahl, 2006).

Conclusion. The practical application of open collaborative learning in Kazakhstan showcases its potential to revolutionize teacher training, particularly in informatics education. With continued investment in digital infrastructure, professional development, and innovative teaching methodologies, OCL will become an integral part of preparing highly qualified and adaptable educators in the country. The didactic model of COL demonstrates strong potential in enhancing the subject knowledge, collaborative skills, and teaching readiness of future computer science teachers. Implementation requires careful scaffolding, digital support, and professional preparation of instructors. (Jurkowski & Abramczyk A, 2024). Future research should expand on larger samples with longitudinal data. The didactic model of COL demonstrates strong potential for enhancing programming knowledge, collaborative competences, and teaching readiness of future computer science teachers. Future research should involve larger samples and longitudinal data. In addition, the integration of open collaborative learning into teacher education programs contributes to the development of reflective practice and lifelong learning skills, which are essential for educators in rapidly evolving digital environments. By engaging future teachers in authentic collaborative tasks, OCL fosters learner autonomy, critical thinking, and the ability to adapt pedagogical strategies to diverse educational contexts. These competencies are particularly important in informatics education, where technological change demands continuous professional growth. Furthermore, the adoption of COL encourages the alignment of teacher training with international educational standards and promotes academic openness and knowledge sharing. Institutional support, policy alignment, and the development of quality digital learning resources will play a key role in ensuring sustainable implementation. Overall, the findings indicate that open collaborative learning represents a promising pedagogical approach capable of strengthening both theoretical and practical components of teacher preparation, thereby enhancing the quality and relevance of computer science teacher education in Kazakhstan.

In addition, the proposed didactic model can serve as a transferable framework that may be applied not only within Kazakhstan but also in other teacher education systems experiencing similar challenges related to digitalization and the preparation of computer science educators. From a methodological standpoint, the integration of collaborative project-based activities, digital educational platforms, and guided instructional facilitation creates an approach that is both systematic and adaptable for competence development.

Future investigations should rely on mixed-method research methodologies that combine quantitative indicators of academic performance with qualitative analysis of student engagement, interaction, and instructional effectiveness. Comparative studies conducted across different cultural and educational contexts could further expand the empirical foundation of the research and improve the broader

applicability of the findings. By positioning open collaborative learning within a well-structured methodological framework, this study contributes to contemporary international discussions on innovative teacher education and highlights the potential of COL as a sustainable approach for preparing future computer science teachers in modern digital learning environments.

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DIAGNOSING THE EDUCATIONAL COMPONENT OF FUTURE BIOLOGY TEACHERS USHING THE 4C APPROACH

Abstract

The article explores the role of the 4C approach in contemporary education and analyzes the diagnostic results concerning the educational component of future biology teachers' professional competence. The study aims to determine the level of development of critical thinking, communication, collaboration, and creativity skills among future biology teachers and to examine the obtained results in relation to indicators of their professional preparation. The relevance of the research is associated with the growing need to prepare teachers who are able to perform professional tasks effectively, analyze information, make well-grounded decisions, interact productively with other participants in the educational process, and generate new pedagogical ideas in response to changing educational demands. Within the study, the four components of the 4C framework are regarded as significant indicators contributing to the professional competence of future teachers. The diagnostic findings demonstrate that these skills are developed unevenly among students and are characterized by different levels of proficiency. The obtained results emphasize the importance of purposefully developing 4C skills throughout the professional preparation of future biology teachers. The study concludes that the systematic integration of the 4C approach into educational content and practice-oriented learning activities can contribute to strengthening students' professional competence and preparing them to address current challenges in their future pedagogical practice.

Keywords: professional competence, 4C, communication, collaboration, critical thinking, creativity.