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DEVELOPING DIGITAL COMPETENCIES IN FUTURE TEACHERS IN AN INCLUSIVE EDUCATION ENVIRONMENT

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Abstract. This article examines current issues in developing digital competencies in future teachers in an inclusive education environment. Particular attention is paid to the DigCompEdu (Digital Competence Framework for Educators) and UDL (Universal Design for Learning) models, as well as the issue of considering digital competencies in future teachers in an inclusive education environment as a system of interconnected components.

The relevance of this research lies in the intersection of two global issues: inclusive education and digital competence. The results of this research demonstrate the need to abandon the fragmented training model, where digital technologies are studied as a separate technical unit. A more promising approach is a comprehensive format in which digital competencies are developed in conjunction with teaching methods, practice, assessment, and reflection.

The purpose of this research is to identify areas for developing digital competencies in future teachers in an inclusive education environment by analyzing modern approaches and reviewing the works of Russian and international authors. It concludes that teacher education needs to be updated to enable a transition from "platform proficiency" to the professionally meaningful use of the digital environment.

Keywords: future teachers, digital competence, DigCompEdu, UDL, inclusive educational environment.

Introduction.

The digitalization of education and the development of an inclusive educational environment are now not parallel processes, but rather interpenetrating ones. While previously, digital competence in teachers was primarily defined as the ability to use platforms, services, and electronic resources in the educational process, in today's environment its scope has expanded significantly [1]. For future teachers, the ability to design a digital environment that is accessible, safe, adaptive, and pedagogically appropriate for different categories of students, including children with special educational needs, is becoming fundamentally important [2]. Therefore, the issue of developing digital competencies in future teachers in an inclusive education environment is acquiring not only a methodological but also a strategic dimension.

Modern research shows that a teacher's possession of basic digital skills does not in itself guarantee the quality of inclusive practice. The ability to transform digital tools into pedagogical support tools is becoming increasingly important: using multimodal texts, utilizing adaptive and assistive technologies, designing tasks of varying difficulty levels, providing feedback, digital diagnostics, and support for students. International research also indicates that a persistent barrier remains the lack of teacher training in digital inclusion, particularly in terms of accessibility, universal learning design, digital ethics, and support for students with special educational needs [3,4].

Teachers must be able to select and create digital resources that ensure content accessibility, multiple ways of presenting information, flexible interaction, and the participation of students with diverse cognitive, sensory, and communicative abilities. In this context, the DigCompEdu framework as a model of digital teacher competence and UDL as an approach to designing learning that takes

into account the diversity of educational needs are of particular methodological significance. Recent research confirms that digital tools become a factor in inclusion only when used methodologically competently and pedagogically meaningful [5,6]. Domestic publications also indicate growing interest in this issue. Kazakhstani studies emphasize the need to develop digital competence in future teachers through electronic educational resources, professional self-development, the structure of digital competence for educational psychologists, and the training of special educators using the DigCompEdu framework [7, 8, 9]. However, the integration of digital training for future teachers with the objectives of inclusive education remains insufficiently addressed, which determines the scientific significance of this work.

The purpose of this research is to theoretically substantiate and empirically characterize the development of digital competence in future teachers within an inclusive education context.

Research objectives:

- to clarify the concept of "digital competence in future teachers" in an inclusive context;
- to determine the structural components of this competence;
- to assess the initial level of digital competence in students majoring in pedagogy;
- to suggest areas for improving professional training.

The scientific novelty of this research lies in its approach to developing digital competencies in future teachers as a unified approach encompassing three dimensions: digital technology, methodological pedagogical approach, and inclusive adaptation. Unlike a narrow understanding of digital literacy, the proposed approach focuses on preparing teachers capable of designing accessible and flexible educational environments for students with diverse learning needs.

Research materials and methods. The research is of a mixed, primarily diagnostic and analytical nature. The first stage involved an analysis of current literature on teachers' digital competence, the preparation of future teachers for inclusive digital education, and the use of DigCompEdu and UDL (Universal Design for Learning). The second stage involved an empirical self-assessment assessment developed based on a combination of the DigCompEdu framework and UDL principles, taking into account current research on the digital competence of future teachers and the specifics of an inclusive educational environment. Unlike more narrowly focused questionnaires that primarily measure the frequency of digital resource use, the proposed questionnaire allows for an assessment not only of technological proficiency but also of future teachers' readiness to design accessible, flexible, and pedagogically meaningful digital learning experiences for students with diverse learning needs.

The research involved 39 third-year students in the educational programs 6B01101 - Pedagogy and Psychology, 6B01301 - Theory and Methodology of Primary Education, Department of General Pedagogy, Caspian University of Technologies and Engineering. Named after Sh. Yesenov.

The author's questionnaire, "Determining the Level of Digital Competence of Future Teachers in an Inclusive Education Environment," includes 30 statements distributed across six scales: motivational-value, cognitive, operational-technological, methodological-design, inclusive-adaptive, and reflective-evaluative. This structure aligns with the concept of this study, which interprets the digital competence of future teachers as a multi-component development, combining digital-technological, pedagogical, and inclusive-adaptive dimensions. The questionnaire includes the following sections:

1. Motivational-value component. This section is designed to determine the extent to which future teachers embrace digitalization and inclusiveness as a professional norm, rather than as an external requirement. This component is important because research shows that digital competence develops more sustainably in those with an internal readiness to use technology to expand learner participation, rather than simply for the formal use of platforms.

2. Cognitive component. This component assesses knowledge of digital platforms, digital ethics, UDL principles, accessibility, and assistive technologies. In modern research, a lack of knowledge about pedagogical integration and adaptation of digital content is identified as one of the main weaknesses of future teachers.

3. Operational-technological component. This component reflects the actual proficiency in digital tools, platforms, communication tools, and content creation. According to both Kazakh and international studies, it is at this level that students most often have basic training, but this often does not translate into professionally oriented application [10, 7].

4. Methodological-design component. This component is fundamentally important and allows us to go beyond "digital literacy" and move on to assessing the extent to which future teachers are capable of designing learning. Recent publications emphasize that it is the integration of technology, methodology, and content that distinguishes professional digital competence from a set of technical skills [11-13].

5. Inclusive-adaptive component. This component is declared to be central and therefore includes statements about accessibility, format adaptation, Variability in information presentation and the use of assistive devices [3,11].

6. Reflective-evaluative component. Modern models of digital competence emphasize that teachers should not only use digital tools but also analyze their effectiveness, ethics, and pedagogical appropriateness. Therefore, the questionnaire must include this component. [19]

Table 1. Questionnaire for determining the level of digital competencies of future teachers in the context of inclusive education

Question Number	Statements
Motivational and Value Component	
1	I believe that digital technologies are a necessary condition for high-quality inclusive education.
2	I am willing to use digital tools to accommodate the individual educational needs of students.
3	I consider the accessibility of digital content a mandatory requirement for a modern lesson.
4	I am interested in mastering new digital solutions for teaching children with different abilities.
5	I believe that digital technologies can increase the participation and independence of students with special educational needs.
Cognitive component	
6	I understand the basic principles of UDL and how to apply them when preparing digital materials.
7	I understand the accessibility requirements for digital educational resources.
8	I understand the capabilities of assistive technologies for students with sensory, cognitive, and communication disabilities.
9	I understand how to ensure digital security, privacy, and the ethical use of student data.
10	I know which digital tools are suitable for differentiating assignments and presenting material in different formats.
Operational and technological component	
11	I am comfortable working with educational platforms (e.g., Moodle, Google Classroom, Microsoft Teams, etc.).
12	I can select and use digital resources to explain new material.
13	I can create digital educational content (presentations, interactive assignments, videos, infographics, quizzes).
14	I can organize online interaction and collaboration among students in a digital environment.

15	I can use digital tools for monitoring, feedback, and assessment of learning outcomes.
Methodological and design component	
16	I can select digital tools according to the purpose, content, and stage of the lesson.
17	I can design digital assignments taking into account the different levels of students' abilities.
18	I can combine in-person, distance, and blended learning when solving pedagogical problems.
19	I can plan digital support for students' independent work.
20	I can develop a lesson plan in which digital technologies are used not formally, but in a didactically sound manner.
Inclusive and adaptive component	
21	I can adapt digital materials for students with diverse learning needs.
22	I can present educational information in multiple formats: text, visual, auditory, and interactive.
23	I can provide alternative ways to complete digital assignments.
24	I can use accessibility features of digital services (subtitles, voice-over, font changes, contrast, screen readers, etc.).
25	I can select digital tools that promote engagement, participation, and independent learning for each student.
Reflexive-evaluative component	
26	I analyze the extent to which selected digital tools effectively support the achievement of learning objectives.
27	I can assess whether digital learning makes learning more accessible for different categories of learners.
28	I can identify my own difficulties in using digital technologies and plan ways to overcome them.
29	I regularly update my knowledge of new digital and assistive tools.
30	I am prepared to adjust digital materials and assignments based on student feedback and performance.

Research Results. The questionnaire is based on the DigCompEdu framework and UDL principles, which assesses not only digital tool proficiency but also the readiness of future teachers to design accessible, flexible, and pedagogically appropriate digital educational environments for students with diverse learning needs. The first framework describes teachers' professional digital competence through resource management, learning, assessment, and student empowerment. The second approach focuses on designing an inherently accessible environment that takes into account diverse modes of perception, participation, and expression of learning outcomes. Their combination appears to be productive for preparing future teachers for work in an inclusive educational environment.

The results are processed using the total score and the average values for each scale. Scoring is based on a five-point Likert scale: 1 - strongly disagree; 2 - somewhat disagree; 3 - partially agree; 4 - mostly agree; 5 - completely agree. With 30 statements, the maximum score is 150 points. This approach evaluates not only the overall level but also the component profile, as a student may demonstrate a strong operational-technological proficiency but weak inclusive-adaptive or reflective readiness. This multidimensional approach is consistent with DigCompEdu and the findings of modern research on the uneven development of digital competence in future teachers [14].

To interpret the results, respondents were classified according to three levels of digital competence: low, medium, and high.

Level	Score Range	Interpretation
Low	30-74	Digital skills are fragmented, technology use is sporadic, and difficulties in adapting content and designing an inclusive digital environment are evident.
Average	75-119	Basic and partially professional digital skills are developed; the student is capable of solving typical pedagogical problems, but requires methodological and inclusive development.
High	120-150	The student confidently and pedagogically uses digital technologies, is capable of designing an accessible and flexible educational environment, and applies assessment and content adaptation.

The survey results revealed a heterogeneous level of digital competence among students. Nineteen students, or 48.7% of the sample, were classified as low-level; 15 students, or 38.5%, were classified as medium-level; and five students, or 12.8%, were classified as high-level.

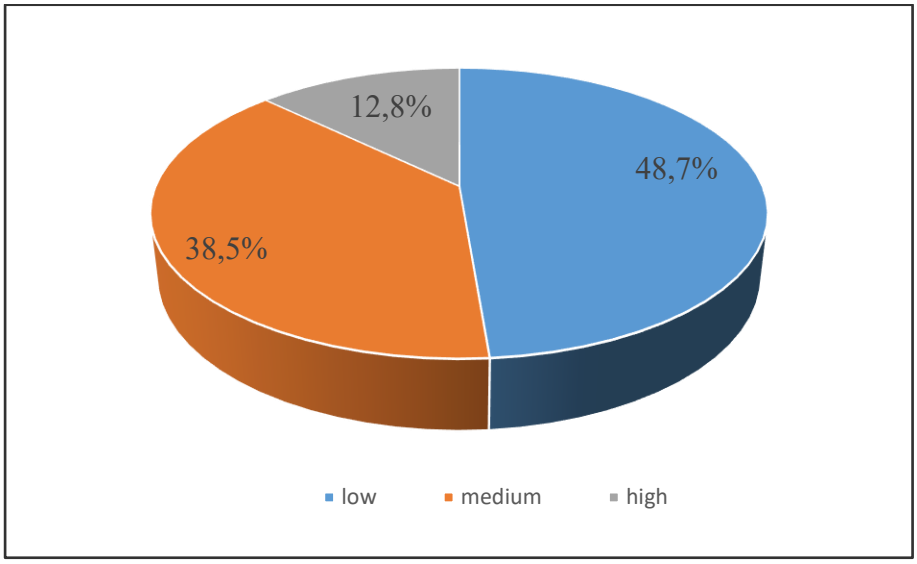

Figure 1 - Survey Results

The data obtained indicate that almost half of the students demonstrate a low level of digital competencies. This points to a fragmented proficiency in digital technologies, their sporadic use, and the presence of significant difficulties in using digital resources in academic and professional activities. These results suggest the need for targeted and targeted work to develop digital competencies already during university preparation.

An analysis of the distribution of responses shows that 38.5% of respondents possessed an average level of digital competencies. This means that students generally possess basic and partially professional digital skills and are capable of solving typical educational and pedagogical problems; however, their experience using digital tools is not yet characterized by consistency, variability, or methodological clarity. These students require further pedagogical support aimed at deepening their skills in selecting, adapting, and pedagogically appropriately using digital tools.

Particularly noteworthy is the fact that only 12.8% of students demonstrated a high level of digital competencies. This group confidently and meaningfully uses digital technologies, is capable of designing accessible and flexible educational environments, and utilizes digital resources to evaluate, adapt, and organize educational content. However, the small size of this category confirms that for most future teachers, digital competence has not yet reached the level necessary for full-fledged professional practice.

A substantive interpretation of the results suggests that the most vulnerable areas are not so much basic technical skills as the ability to pedagogically meaningfully use digital technologies, select appropriate digital tools depending on the educational situation, organize interaction in the digital environment, and adapt content to various educational needs. In an inclusive education setting, this is particularly important, as teachers must not only master digital tools but also be able to apply them in a manner tailored to the individual needs of students, ensuring the accessibility and flexibility of the educational process.

Based on the literature review and diagnostic results, it is advisable to consider the digital competencies of future teachers in an inclusive education setting as a system of interconnected components. First, there is a motivational and value component, reflecting a willingness to embrace digitalization and inclusion as a professional norm. Second, there is a cognitive component, related to knowledge of digital tools, UDL principles, the fundamentals of digital ethics, and the specifics of assistive technologies. Third, there is an operational and technological component, which involves mastery of educational platforms, digital resources, communication, and assessment tools. Fourth, there is a methodological and design component, which reflects the ability to develop digital lessons and adapt content to various educational needs. Fifth, there is an inclusive and adaptive component, which includes the selection of accessible formats, visual support, alternative methods of presenting and completing assignments, and the use of assistive solutions. Sixth, there is a reflective and evaluative component, which enables self-analysis of digital practice and an assessment of its pedagogical effectiveness. The findings are generally consistent with international research showing that students in teacher training programs possessing individual digital skills does not necessarily indicate their professional readiness for digital learning. The significant proportion of respondents with low levels of digital competencies confirms the need to abandon the fragmented training model, where digital technologies are studied as a separate technical unit. A more promising approach is a comprehensive format in which digital competencies are developed in conjunction with teaching methods, practice, assessment, and reflection [15,16].

Developing the digital competencies of future teachers should include not only mastering applications and platforms but also understanding how technologies impact participation, accessibility, and educational equity [17]. In this regard, UDL acts not as an additional element, but as a fundamental framework for pedagogical design. The training of future teachers should be focused on creating a flexible educational environment, where various methods of presenting material, forms of engagement, and options for demonstrating results are foreseen in advance. Combining UDL with DigCompEdu allows us to rethink digital competence as the ability to design inclusive learning, and not just use digital tools according to instructions [18, 2].

Taking into account the results of the study and an analysis of modern literature, it seems necessary to include the following interrelated areas in teacher education programs:

Conclusion. Thus, developing the digital competencies of future teachers in an inclusive education environment should be considered a strategic objective for modern pedagogical universities. The diagnostic results revealed that a significant portion of students require targeted development of digital competencies, not only at the technological level but also at the methodological and inclusive levels. This confirms the need for a systematic update of the training content for future teachers.

The analysis suggests that the most productive model is one that integrates the DigCompEdu framework and UDL principles. This model facilitates a transition from a narrow understanding of digital literacy to the professional readiness of teachers to design accessible, flexible, and pedagogically sound digital environments. Prospects for further research include the development and testing of a training module on developing the digital competencies of future teachers in an inclusive education environment, as well as expanding the sample and refining the diagnostic criteria.

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ФОРМИРОВАНИЕ ЦИФРОВЫХ КОМПЕТЕНЦИЙ БУДУЩИХ ПЕДАГОГОВ В УСЛОВИЯХ ИНКЛЮЗИВНОГО ОБРАЗОВАНИЯ

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Аннотация. В статье рассмотрены актуальные вопросы формирования цифровых компетенций будущих педагогов в условиях инклюзивного образования. Особое внимание уделено моделям DigCompEdu (Digital Competence Framework for Educators) и UDL (Universal Design for Learning), а также вопросу рассматрения цифровых компетенций будущих педагогов в условиях инклюзивного образования как систему взаимосвязанных компонентов.

Актуальность статьи определяется пересечением двух глобальных вопросов: инклюзивного образования и цифровой компетентности. Результаты исследования показывают, что необходим отказ от фрагментарной модели подготовки, когда цифровые технологии изучаются как отдельный технический блок. Более перспективным является сквозной формат, в котором цифровые компетенции развиваются в связи с методикой преподавания, практикой, оцениванием и рефлексией.

Целью статьи является определение направлений формирования цифровых компетенций будущих педагогов в условиях инклюзивного образования путем анализа современных подходов и разбора трудов отечественных и зарубежных авторов. Сделан вывод о необходимости обновления педагогического образования, который позволяет перейти от «владения платформами» к профессионально осмысленному использованию цифровой среды.

Ключевые слова: будущие педагоги, цифровая компетентность, DigCompEdu, UDL, инклюзивная образовательная среда.

ИНКЛЮЗИВТІ БІЛІМ БЕРУ ЖАҒДАЙЫНДА БОЛАШАҚ ПЕДАГОГТЕРДІҢ ЦИФРЛЫҚ ҚҰЗЫРЕТТІЛІГІН ҚАЛЫПТАСТЫРУ

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Аңдатпа. Бұл мақалада инклюзивті білім беру жағдайында болашақ педагогтердің цифрлық құзыреттіліктерін дамытудың өзекті мәселелері қарастырылады. DigCompEdu (Мұғалімдерге Арналған Цифрлық Құзыреттілік Шеңбері) және UDL (Оқытуға Арналған Әмбебап Дизайн) үлгілеріне, сондай-ақ инклюзивті білім беру ортасында болашақ педагогтердің цифрлық құзыреттіліктерін өзара байланысты компоненттер жүйесі ретінде қарастыру мәселесіне ерекше назар аударылады. Бұл зерттеудің өзектілігі екі жаһандық мәселенің тоғысында жатыр: инклюзивті білім беру және цифрлық құзыреттілік. Зерттеу нәтижелері цифрлық технологиялар жеке техникалық бірлік ретінде зерттелетін фрагменттелген оқыту үлгісінен бас тарту қажеттілігін көрсетеді. Перспективалы тәсіл ретінде цифрлық құзыреттілік оқыту әдістерімен, практикамен, бағалаумен, рефлексиямен бірге дамитын кешенді формат қарастырылады. Зерттеудің мақсаты - заманауи тәсілдерді талдау және отандық, халықаралық авторлардың еңбектеріне шолу жасау арқылы инклюзивті білім беру жағдайында болашақ мұғалімдердің цифрлық құзыреттіліктерін дамыту бағыттарын анықтау. Онда "платформаны меңгеруден" цифрлық ортаны кәсіби тұрғыдан мағыналы пайдалануға көшуді қамтамасыз ету үшін болашақ пелагогтердің білімін жаңарту қажет деген қорытындыға келді.

Түйін сөздер: болашақ мұғалімдер, цифрлық құзыреттілік, DigCompEdu, UDL, инклюзивті білім беру ортасы.