ПЕДАГОГІЧНА АКАДЕМІЯ:
НАУКОВІ ЗАПИСКИ

ТЕОРІЯ І МЕТОДИКА ПРОФЕСІЙНОЇ ОСВІТИ

УДК 378.091.31-059.1-051

DOI https://doi.org/10.5281/zenodo.14178615

Organisation, Methodology, and Analysis of Experimental Research on the Formation of Professional Competence of Bachelor's Degree Students in Computer Technology in the Context of Blended Learning with Elements of Dual Education

Lobatskyi Andrii Oleksandrovych

Postgraduate Student of the Department of Computer Technologies, Ternopil Volodymyr Hnatiuk National Pedagogical University, 2 Maksyma Kryvonosa Str., Ternopil, 46000, Ukraine; https://orcid.org/0009-0009-1497-4977

Прийнято: 13.10.2024 | Опубліковано: 29.10.2024

Abstract. *The* ***purpose*** *of the article is devoted to analysing the experimental work on the effectiveness of pedagogical conditions and the effectiveness of the structural and functional model of formation of professional competence of bachelors in computer technology in the conditions of blended learning with elements of dual education. The stages of the pedagogical experiment (stating, formative, and final) are considered. Achieving the goal involved the use of the following* ***methods****: theoretical (content analysis, systematisation, specification and synthesis), empirical and statistical to present a quantitative and qualitative analysis of empirical data of the results of the pedagogical experiment.*

The results*. A comparative analysis of the results obtained in the empirical study in the experimental (EG) and control groups (CG) allows us to conclude that the proposed set of pedagogical conditions and the developed structural and functional*

model of the formation of professional competence of bachelors in the field of computer technology in the conditions of blended learning with elements of dual education were effective. This is confirmed by the dynamics of the formation of professional competence of bachelors in the field of computer technology of EG and CG at the beginning and end of the pedagogical experiment. Thus, the high level of students in CG increased by 2.53% and in EG - by 20.00% (17.47% more in EG); the number of students with a sufficient level decreased by 5.06% in CG, and in EG increased by 7.50% (12.56% more in EG); in CG, the number of students with an initial level also increased by 2.53%, while in EG it decreased by 27.50%. ***The conclusions.*** *The results confirmed the effectiveness of the pedagogical efforts that contributed to solving the research objectives.*

Keywords: *research work, ascertaining and formative experiment, bachelor students, experimental and control groups, flipped classroom technology, digitalisation of education, dual learning.*

Організація, методика та аналіз дослідно-експериментальної роботи щодо формування фахової компетентності бакалаврів сфери комп'ютерних технологій в умовах змішаного навчання з елементами дуальної освіти

Лобацький Андрій Олександрович

аспірант кафедри комп'ютерних технологій, Тернопільський національний педагогічний університет імені Володимира Гнатюка, 46000, Україна, м. Тернопіль, вул. Максима Кривоноса, 2; https://orcid.org/0009-0009-1497-4977

Анотація. *Статтю присвячено аналізу дослідно-експериментальної робото щодо дослідження дієвості педагогічних умов та результативності структурно-функціональної моделі формування фахової компетентності бакалаврів сфери комп'ютерних технологій в умовах змішаного навчання з*

елементами дуальної освіти. Розглянуто етапи проведення педагогічного експерименту (констатувальний, формувальний, підсумковий). Досягнення мети передбачало використання таких ***методів****: теоретичних (контент-аналіз, систематизація, конкретизація та синтез), емпіричних та статистичних для презентації кількісного та якісного аналізу емпіричних даних результатів педагогічного експерименту.*

Результати*. Порівняльний аналіз результатів, отриманих під час емпіричного дослідження в експериментальних (ЕГ) та контрольних групах (КГ), дає змогу зробити висновок про те, що запропонований комплекс педагогічних умов та розроблена структурно-функціональна модель формування фахової компетентності бакалаврів сфери комп'ютерних технологій в умовах змішаного навчання з елементами дуальної освіти виявилися ефективними. Це підтверджено динамікою сформованості фахової компетентності бакалаврів сфери комп'ютерних технологій ЕГ та КГ на початку та вкінці педагогічного експерименту. Так, високий рівень в студентів КГ зріс на 2,53 %, а в ЕГ – на 20,00 % (в ЕГ на 17,47 % більше); в КГ зменшилася кількість студентів з достатнім рівнем на 5,06 %, а в ЕГ зросла на 7,50 % (загалом в ЕГ на 12,56 % більше); в КГ також на 2,53 % зросла кількість студентів з початковим рівнем, тоді як в ЕГ зменшилася на 27,50 %.* ***Висновки.*** *Отримані результати підтвердили ефективність педагогічних зусиль, що сприяюли розв'язанню завдань дослідження.*

Ключові слова: *дослідна робота, констатувальний та формувальний експеримент, студети-бакалаври, експериментальні та контрольні групи, технологія «перевернутий клас», цифровізація освіти, дуальне навчання.*

Problem statement. The rapid development and penetration of digital technologies into all spheres of life cause society to transition to a new technological level. The strategic importance of digitalisation in ensuring the state's leading position in the global economy, as well as its independence and security, necessitates the

development of a set of measures to develop the information society and form a national digital economy. At the same time, any programmes for the digitalisation of the economy and social sphere will be effective only if there is a high level of professional competence of specialists of different qualification levels, their ability to integrate production, management and digital technologies, and to carry out digitalisation-based modernisation processes in their professional activities. That is why improving the quality of training of bachelors of computer technology (BCT) as vocational teachers is one of the key issues of modern vocational education.

The analysis of BCT's training practice shows that in higher education institutions, the problem of professional training through blended learning and using elements of dual education requires additional reflection and special measures at different levels. Under the traditional education system, students are not sufficiently prepared to deal with complex professional situations in the context of global informatisation.

In order to test the hypothesis of the study, the significance of the pedagogical conditions and the effectiveness of the structural and functional model of the formation of professional competence of BCT in the conditions of blended learning with elements of dual education, a pedagogical experiment was conducted, which in scientific research is defined as a set of tools and methods of scientific knowledge that provides scientific evidence and objective verification of the correctness of the hypothesis justified at the beginning of the study [1]. The pedagogical experiment made it possible to establish the nature of the links between different components of the educational process, factors, conditions and results of pedagogical influence; to compare the effectiveness of different factors or changes in the structure of the process; to identify the necessary conditions for the implementation of a particular set of tasks by known means and the peculiarities of the process in new conditions.

Recent research and publications analysis. The study of the problem of training future specialists, including bachelors in the field of computer technology in the domestic educational space concerns the following aspects: theoretical and methodological foundations of vocational education (R. Gorbatyuk, M. Rutilo, & S. Sitkar, (2022) [2], N. Titova (2018) [3], and others); implementation of innovative and information technologies of education (V. Savitska (2022) [4], O. Trifonova (2019) [5] and others); the potential of blended learning as an innovative form of organising the educational process in higher education institutions (M. Kademia, S. Kizim, S. Lyulchak, & I. Savchuk (2019) [6] et al.); Prospects for the introduction of blended learning and dual education in the educational process of modern higher education institutions (O. Romanyshyna, & A. Dundyuk (2021) [7] and others). However, despite the undoubted significance of the research, the issue of effective use of e-learning resources and elements of dual education remains insufficiently addressed.

Identification of previously unresolved parts of the overall problem. The current reality is that the integrated introduction of communication systems (integration of mobile telephony, computer networks, satellite and cable video communications) and virtual reality technologies have brought traditional and distance education to a new quality level - causing their integration and interpenetration in the context of blended learning. An integral part of blended learning is the use of e-learning resources that allow for visualising learning material and adapting it to the individual personal abilities of students. Moreover, the variety of their types and forms makes e-learning resources a key component of various forms of classroom management: lectures, seminars, practical and laboratory classes, control measures, and independent work.

One of the most important aspects of professional competence formation is the introduction of elements of dual learning, which is logical and justified given the very essence of the activities and training of bachelors in computer technology. The

innovative paradigm of "lifelong learning" is determined by the presence of two factors: education (development of citizens' abilities) and economy (optimal use of human resources) [8, c. 30]. At the same time, the analysis of scientific literature and primary documentation of higher education institutions has shown that the problem of forming the professional competence of BCT in the conditions of blended learning with elements of dual education has not yet become the subject of a special scientific and pedagogical study, and, in fact, within the theory and methodology of vocational education has not yet found proper theoretical justification and appropriate methodological support. Therefore, the problem of modernisation and search for innovative approaches to improving the quality of professional training of bachelors in the field of computer technology based on the ideas of blended learning and elements of dual education is extremely relevant.

Formulation of the aims of the article. The article aims to present and analyse the main points of planning and organising a pedagogical experiment to test the effectiveness of pedagogical conditions and the efficiency of the structural and functional model of the formation of professional competence of BCT in the context of blended learning with elements of dual education.

Research results. In order to empirically confirm the scientific value, validity and effectiveness of the substantiated pedagogical conditions and the developed structural and functional model of the formation of professional competence of bachelors of computer technologies in the conditions of blended learning with elements of dual education, a pedagogical experiment was implemented. This made it possible to identify and form the necessary and sufficient conditions for testing the proposed structural and functional model of the formation of professional competence of bachelors in the field of computer technology in the conditions of blended learning with elements of dual education to ensure the objectivity of the data, the possibility of

their critical evaluation, systematisation, generalisation and repeated practical application.

The choice of the method of pedagogical experiment is due to a combination of its advantages. Firstly, it allows the structure of the links between different components of professional competence. This approach helps identify the conditions and factors contributing to its formation [9]. Secondly, the pedagogical experiment makes it possible to regulate the conditions of pedagogical influence on the BCT, which makes it possible to identify effective methods and approaches that should be used to improve the effectiveness of forming BCT professional competence in blended learning with elements of dual education. A pedagogical experiment is an essential tool in research that facilitates the reproduction and study of various phenomena and phenomena in controlled conditions, which helps to establish cause-and-effect relationships and obtain more accurate results and conclusions [10]. One of the advantages of a pedagogical experiment is the ability to create conditions that are as close as possible to real-life situations. This allows researchers to control various variables and isolate factors affecting the process or phenomenon under study [11]. Therefore, a pedagogical experiment is a scientifically reasoned and carefully considered system of organising the educational process to discover new pedagogical knowledge, clarifying and substantiating pre-existing scientific assumptions and hypotheses.

During the experimental work, repeated, strong, significant connections between different pedagogical phenomena were revealed [12], which made it possible to study the patterns of formation of BCT's professional competence in blended learning conditions with dual education elements. The conditions of the university environment made it possible to intensify the educational process in order to study the phenomenon under study in pre-planned parameters and to vary the factors influencing the formation of the professional competence of BCT in the conditions of blended learning with elements of dual education, and to reproduce them repeatedly.

In the experimental work, new experience was gained in specific conditions. In particular, the data of the formative experiment recorded the following states in the professional training of BCT, which actualised the development of special measures aimed at the formation of professional competence by increasing the effectiveness of targeted pedagogical activities and expanding the range of actions to gain experience in the professional activities of BCT. The results of the formative experiment indicated the dynamics of the formation of the professional competence of BCT in the conditions of blended learning with elements of dual education in the process of intensive and positive research work based on the principle of the unity of theory, experiment and practice.

Ternopil Volodymyr Hnatiuk National Pedagogical University, Rivne State University of Humanities, and National Pedagogical Dragomanov University were chosen as the experimental base for the study. The experimental study was conducted with students of the speciality 015.39 Vocational Education (Digital Technologies).

Table 1 presents the plan of the pedagogical experiment, which includes the statement, formative, and final stages.

Table 1

Plan of Pedagogical Experiment on Forming the Professional Competence of Bachelors in the Field of Computer Technology in Conditions of Blended Learning with Elements of Dual Education

The statement stage (2020 academic year)
1. Formulation of the goal and its details.
2. Selection of the required number of experimental sites: HEIs, study groups, forms of education, and number of respondents.
3. Development of a methodology for conducting a pedagogical experiment.
4. Development of a criterion-evaluation apparatus.

5. Identify specific scientific methods to determine the initial state of the experimental object. 6. Identification of signs of potential changes in the experimental object due to pedagogical influences.
Formative stage (2021-2024 academic year)
1. Establishing the initial level of professional competence of BCT participating in the pedagogical experiment. 2. Briefing the participants of the pedagogical experiment. 3. Implementation of pedagogical conditions and introduction of a structural and functional model for the formation of professional competence of BCT in the context of blended learning with elements of dual education. 4. Recording intermediate results that indicate the dynamics of the experimental object. 5. Recording difficulties during the pedagogical experiment.
The final stage (2024)
1. Conducting a control section at the final stage and recording the results of the control section of the pedagogical experiment. 2. Processing the results using special statistical methods. 3. Displaying the results of the pedagogical experiment.

Within the framework of the ascertaining stage of the experimental work, the diagnostics of the presence and initial characteristics of BCT's professional competence were carried out. A set of developed criteria and indicators was used to assess the level of formation of its components.

The assessment stage covered 109 BCT in total. At this stage, based on the analysis of diagnostic sections, a theoretical justification for improving BCT professional training was made, which is reflected in Table 2.

Table 2

Results of Forming the Professional Competence of Bachelors in the Field of Computer Technology at the Establishment Stage of the Experiment

Levels	Control at the beginning of the experiment							
	Components of the professional competence of the BCT							
	Motivational and value-based		Information and cognitive		0 operational and activity		Personality-reflective	
	number	%	number	%	number	%	number	%
High	20	18,35	19	17,43	21	19,27	18	16,51
Sufficient	35	32,11	37	33,94	36	33,03	34	31,19
Initial	54	49,54	53	48,62	52	47,71	57	52,29

The analysis of the results of the ascertaining stage of the experiment showed the insufficient effectiveness of the process of training of BCT, which indicates the relevance of the study and the need to introduce pedagogical conditions and a structural and functional model of the formation of BCT professional competence in the context of blended learning with elements of dual education in the educational process of higher education institutions. These circumstances determined the formative stage of the experiment, which was carried out during the academic year 2022-2024. At the beginning of *the formative stage of* the study, experimental (EG) and control (CG) groups were formed from third-year students majoring in 015.39 "Vocational Education. Digital Technologies", who had no significant differences in the indicators of the input level of professional competence.

Considering the humanistic ideas that "personal and professional growth of an individual should be evaluated, first of all, from the position of himself" [13, p. 185], and the results of students' educational activities should be compared not with the results of other students, but with their results, which are at the initial stage and

obtained after the end of educational activities [14], it was decided to form one experimental group (EG). In order to ensure the representativeness of the data obtained, students from 5 groups were involved in the experiment. As a result, 159 students took part in the experiment.

A specific feature of the pedagogical experiment is the possibility of repeated reproduction of the phenomena under study in varying conditions regarding accurate measurement of their parameters [15]. The analysis of the scientific and pedagogical literature on the research topic made it possible to identify a set of variable conditions for conducting a formative experiment:

1) the educational process in the EG was based on the traditional model, while in the EG - on the developed structural and functional model, the mechanism of implementation of which was the pedagogical conditions for the formation of professional competence of BCT in the conditions of blended learning with elements of dual education. At the same time, blended learning involved using traditional and online learning, so it was necessary to develop e-learning courses to support the traditional form of learning. In the EG, blended learning was used, in which lectures were held traditionally, and laboratory classes were held using electronic technologies;

2) unlike CG, EG students were informed about the facts and methodology of the pedagogical experiment;

3) the experimental effects on the EG were directed in a way that corresponded to the study's goals and objectives.

The essence of the pedagogical experiment involves a comparative analysis of CG and EG, which should be comparable in terms of basic indicators of equality of initial conditions that are essential from the perspective of the study [16, p. 68], which involves checking their homogeneity. The study of CG and EG students in the fourth year coincided with the final stage of implementation of pedagogical conditions and implementation of the structural and functional model of the formation of professional

competence of BCT in the conditions of blended learning with elements of dual education, and therefore - with the completion of the formative stage of the experiment and the beginning of the *final stage* (2024) with the subsequent display and processing of the data obtained.

The final stage involved summarising all the empirical data and comparing the results obtained at the formative and formative stages of the research and experimental work; displaying and interpreting the experimental data, as well as their quantitative and qualitative analysis; comparing the experimental work's results with the goal and objectives; formulating the main conclusions and presenting the results.

The diagnostics made it possible to state positive changes in the formation of BCT's professional competence in general. A comparative analysis of the data obtained at the formative and summative stages of the experimental work clearly demonstrates the sustainability of positive results and successful dynamics in all components of BCT's professional competence formation (Table 3).

Table 3

Generalised Results of Establishing Digital Indicators of the Levels of Professional Competence of Bachelors in the Field of Computer Technology in Conditions of Blended Learning with Elements of Dual Education

Levels	**Groups**	**Components of the professional competence of the BCT**							
		Motivational and value-based		Information and cognitive		0 operational and activity		Personality-reflective	
		number	**%**	**number**	**%**	**number**	**%**	**number**	**%**
High	CG (79)	11	13,92	9	11,39	11	13,92	10	12,66
	EG(80)	24	30,00	20	25,00	25	31,25	25	31,25
Sufficient	CG (79)	22	27,85	20	25,32	21	26,58	22	27,85
	EG(80)	32	40,00	32	40,00	32	40,00	33	41,25
Initial	CG (79)	46	58,23	50	63,29	47	59,49	47	59,49
	EG(80)	24	30,00	28	35,00	23	28,75	22	27,50

Thus, a comparative analysis of the results obtained during the empirical study in the EG and CG allows us to conclude that:

- the proposed complex of pedagogical conditions for the formation of professional competence of BCT in the conditions of blended learning with elements of dual education proved to be effective;

- the structural and functional model of the professional competence of BCT in blended learning with elements of dual education, developed at the stage of conceptual design, was implemented in the developed programme and system of didactic work with educational subjects;

- the developed and tested in the educational process of electronic teaching and learning materials in the discipline "Web-programming" contributed to the formation of professional competence of BCT, which significantly increased the quality and sustainability of cognitive interest in professional and pedagogical activities, the development of productive mental activity, and readiness to use computer technologies in professional and pedagogical activities;

- the formed set of digital resources and online platforms positively impacted the formation of all components of the BCT's professional competence, and the applied information and computer technologies made students' independent work more fruitful and effective.

Conclusion. Thus, the experimental study found a statistically significant difference in the levels of professional competence of BCT in the conditions of blended learning with elements of dual education, which indicates a positive dynamics of the formation of the studied phenomenon during the experimental work, which is reflected in the context of the tasks of the article. The experiment involved students of the control and experimental groups of Ternopil Volodymyr Hnatiuk National Pedagogical University, Rivne State University of Humanities, and National Pedagogical Dragomanov University during the academic years 2020-2024. The experiment was carried out in three stages: stating, formative, and final. The ascertaining stage is the

determination of the initial level of professional competence of the BCT; the formative stage is the implementation of pedagogical conditions in the pedagogical practice of training of BCT who studied in EG and the introduction of a structural and functional model of the formation of professional competence of BCT in blended learning with elements of dual education; the final stage is a critical evaluation of the results. The results of the final stage of the experiment, which indicate the positive dynamics of the studied process and the increase in the number of BCT with high and sufficient levels of professional competence, confirmed the effectiveness of pedagogical conditions and the efficiency and effectiveness of the developed structural and functional model of professional competence development of BCT in the conditions of blended learning with elements of dual education.

References:

1. Сисоєва С. О. Кристопчук Т. Є. Педагогічний експеримент в наукових дослідження неперервної професійної освіти: навч.-метод. посіб. Луцьк: Волинська обласна друкарня, 2009. 460 с.
2. Горбатюк, Р. М., Рутило, М. І., & Сіткар, С. В. (2022). Інформаційно-освітнє середовище підготовки майбутніх фахівців з професійної освіти. *Філософські аспекти професійної освіти*. Матеріали X Міжнар. наук.-практ. конф. (Херсон – Кропивницький, 17 листопада 2022 р.). (238–240). Херсон; Кропивницький: Поліум.
3. Титова, Н. М. (2018). *Теоретико-методичні основи психолого-педагогічної підготовки майбутніх педагогів професійного навчання*. [Монографія]. Київ: НПУ імені М. П. Драгоманова, 352.
4. Савіцька, В. В. (2022). *Теоретико-методологічні основи проєктування освітнього процесу у закладах вищої освіти в умовах цифровізації*.

Інноваційні технології навчання в умовах модернізації сучасної освіти. [Колективна монографія] / за заг. ред. Л. З. Ребухи. Тернопіль: ЗУНУ, 67–83.

5. Трифонова, О. М. (2019). Теоретичні та педагогічні аспекти методичної системи розвитку інформаційно-цифрової компетентності майбутніх фахівців комп'ютерних технологій. *Сучасні інформаційні технології та інноваційні методики навчання в підготовці фахівців: методологія, теорія, досвід, проблеми*, 3, 234–238.
6. Кадемія, М. Ю., Кізім, С. С., Люльчак, С. Ю., & Савчук, І. В. (2021). Реалізація змішаного навчання засобами цифрового освітнього середовища. *Сучасні інформаційні технології та інноваційні методики навчання в підготовці фахівців: методологія, теорія, досвід, проблеми*, 62, 249–256.
7. Романишина, О. Я., & Дундюк, А. Ю. (2021). Дуальна освіта як одна з умов формування професійної компетентності техніків-технологів. *Науковий вісник Ужгородського університету. Серія: Педагогіка. Соціальна робота*, 1 (48), 361–364.
8. Ткачук Г. Аналіз та особливості впровадження моделей змішаного навчання в освітній процес закладу вищої освіти. *Наукові записки. Серія педагогіка*. 2018. Вип. 3. С. 28–36.
9. Гальченко С. І., Силка О. З. Основи наукових досліджень: навч.-метод. посіб. Черкаси: АММО, 2015. 256 с.
10. Золотухіна С. Т., Лозова В. І. Експеримент у системі педагогічного дослідження. *Психолого-педагогічні проблеми вищої і середньої освіти в умовах сучасних викликів: теорія і практика*. Матеріали IV Міжнар. наук.-практ. конф., (Харків, 12 груд. 2019 р.). Харків. нац. пед. ун-т ім. Г. С. Сковороди, Харків, 2019. С. 174–176.
11. Важинський С. Е., Щербак Т. І. Методика та організація наукових досліджень: навч. посіб. Суми: СумДПУ імені А. С. Макаренка, 2016. 260 с.

12. Козловський Ю. М. Методологія педагогічного дослідження: навч. посіб. Львів: Видавництво Львівської політехніки, 2018. 196 с.
13. Самсонов В. В., Сільвестров А. М., Тачиніна О. М. Методологія наукових досліджень та приклади її використання: навч. посіб. К.: НУХТ, 2022. 385 с.
14. Шейко В. М., Кушнаренко Н. М. Організація та методика науково-дослідницької діяльності: підруч. 6-те вид., перероб. і допов. Київ: Знання, 2011. 311 с.
15. Ochrana F. Metodologie, metody a metodika vědeckého výzkumu. Univerzita Karlova, 2019. 150 p.
16. Данильян О. Г., Дзьобань О. П. Методологія наукових досліджень. [Підручник]. Харків: Право, 2019. 368 p.