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FORMATION OF BACHELORS OF INFORMATICS COMPETENCE IN THE USE OF OPEN SYSTEMS NETWORK TECHNOLOGIES

Abstract. The article examines the problem of formation of Bachelors of Informatics competence in the use of open systems network technologies (OSNT). It is substantiated that OSNT selection for the higher educational institutions should be performed according to the following characteristics such as management supporting, commitment to the end-user, establishment of three-dimensional interaction, realization of the implementing tasks and user service. The criteria, indicators and levels of competence of the Bachelors of Informatics in relation to OSNT are identified. The basic stages of pedagogical experiment in relation to OSNT use for the future Bachelors of Informatics are described. The experimental implementation of the study results showed that the application of the special methodology in the training of Bachelors of Informatics contributes to their competence in the use of OSNT. The conducted experimental research attests the positive dynamics of Bachelors of Informatics growth of competence in using OSNT.

Keywords: open education; open systems network technologies; a Bachelor of Informatics; competence in using OSNT.

1. INTRODUCTION

The problem setting. The informatization of education becomes a modern instrument of its innovative development as the basis for the evolution of open education, characterized by availability and improvement of the information and resources provision for the training methodology, and expanding the range of learning tools and educational technologies. The open learning environment is potentially unlimited in relation to the level of resources that can be applied in the educational process and the number of users. Open systems network technologies diversify the learning process, increase its effectiveness, contribute to the formation of personalities able to quickly acquire new knowledge and apply previously gained one for non-standard situations, think creatively and thoroughly, rationalize promising ideas and implement them in the future activities.

Appearance and widespread implementation of open systems network technologies substantially influence the learning efficiency of Bachelors of Informatics, in particular, promotes the formation of competence in using OSNT. As OSNT relate to information and communication technologies (ICT), the formation of competence in using OSNT will be considered as part of ICT competence. Hence, it is possible to formulate the definition of "competence in using OSNT" as the confirmed ability of the person to use OSNT both in the learning process and topical area.

Analysis of recent studies and publications. Problems of training future teachers of Informatics are investigated in the works of Ukrainian scientists[7]; [10]; [13], as well as foreign, in particular from Poland (Ye. Mazinska [2], H. Kedrovich, etc [9]), USA (A. Thompson[3], R. Bradley, etc), France (G.Arsak [1]), Russia (V. V. Davydov, A. P. Ershov, K.K. Kolin, N.P. Lapchick, etc.).

V.Y. Bykov made a significant contribution to the study of the problem of using open systems network technologies [4]. He analyzed the characteristics, principles and technologies

of open education. Aspects of the formation of open academic environment and the use of open education technologies for training purposes are reflected in the writings [10]; [12]; [5]; [8]. The studies of the leading specialists working in the field of open education in the United States and Europe, in particular, Tory Iiyosi, Vijay Kumar, Stuart D. Lee, Trent Batson, Andy Lane, Marcher S. Smith, Sheryl R. Richardson etc. are relevant nowadays.

However, the problems concerning the methodology of applying open systems network technology in the training of Bachelors of Informatics, in particular, the formation of students' appropriate competence, need further investigation.

The article's goal. Organization of the education of the future Bachelors of informatics based on the methodology of using OSNT allows to increase the effectiveness of the learning process. Therefore, **the aim of the article** is the formation of Bachelors of Informatics competence in the use of open systems network technology.

2. THE RESULTS OF THE STUDY

To achieve the goal and realize the objectives of the study a complex of methods was used. They are: (i) analysis of pedagogical experience in the implementation of open systems network technologies in higher educational establishments; (ii) supervision – to identify features of the education of future Bachelors of Informatics and their moral and ethical behaviour in open educational environment; (iii) pedagogical experiment to evaluate the efficiency of the developed methods; and (iv) methods of mathematical statistics for processing results of the pedagogical experiment.

While modeling the process of specialist training in a higher educational institution, all its aspects should be analysed (educational, scientific, organizational, managerial, educational and the like). It is important to use open systems network technologies in the educational process of higher school.

It is advisable to train the Bachelors of Informatics according to the methodology of using OSNT. The aim is to ensure the use of OSNT of Bachelors of Informatics and to form their appropriate competence. The content of the training is to improve the teaching of IT subjects using OSNT (by the example of the subject "Organizational Informatics"). The students master the course during lectures, laboratory and practical classes and their independent work. Teaching methods are testing, questionnaire, projects and illustrative examples. The training aids include not only the logistical support but, what is important, qualitative educational materials.

In order to carry out selection of OSNT that are appropriate to apply at the university, the next points are worth considering:

- *relations in using*: external (relationships between (i) society – the state, and (ii) general education system – certain educational institutions) and internal (relationships between (i) teachers – teachers; (ii) students – students; (iii) teachers – students; and (iv) educational institution administration – teachers and students;
- *users*: students, as users of the service; teachers engaged in research and teaching; educational authorities that organise and maintain the educational process; employers who use the results of OSNT [4];
- *characteristics*: (i) the universality of technological processes of creation, maintenance and use of educational and other resources to provide the learning process via the Internet; (ii) the integration of various educational institutions; (iii) the invariance of the environment and technology regarding the level and profile of education; (iv) scalability which enables accumulation of resources; (v) broad coverage of all levels of education; (vi) creation and use of the automated workshops park with open access; and (vii)

interest of all participants of educational process;

- *types of services*: informative (digital libraries, textbooks, methodological literature, electronic periodicals, reference files, educational software); interactive (email, conversations on line using ICQ, Skype, Viber, Messenger, etc); search (catalogues and searching systems);
- *risks*: the influence of unreliable, poor-quality information on the personality; the manipulation of the human consciousness; threats from "hacker attacks", the access to personal data; the absence of censorship, limitations of ethical character.

Based on the analysis of scientific publications and personal experience, it is possible to define the qualification criteria and the recommended list of OSNT for the use at the university, as they are given in table 1.

Table 1

The recommended list of OSNT for the use at higher educational institutions

OSNT list: Qualification criteria:	<i>educational and academic network</i>	<i>digital libraries</i>	<i>automated system of texts examination of texts uniqueness</i>	<i>electronic social communities</i>	<i>distance education technologies</i>	<i>mobile education technologies</i>	<i>research-and-development automation technologies</i>
accessibility	+	+	+	+	+	+	+
technical characteristics	+	+	+	+	+	+	+
functionality	+	+	+	+	+	+	+
usability	+	+	+	+	+	+	+
select the complexity level	+	±	+	±	+	+	+
intuitive interface	+	+	+	+	+	+	+
feedback	+	+	+	+	+	+	±
mobility	+	+	+	+	+	+	+
personal data security	+	+	+	+	+	+	+
academic virtue guarantee	+	+	+	+	+	+	+
reserved copyright	+	+	+	+	+	+	+
ethical standards accounting	+	+	+	+	+	+	+

The determination of criteria, indicators and appropriate levels is important for formation of Bachelors of Informatics competence in the use of OSNT. Based on the analysis of scientific research and our own experience the criteria suitable for evaluation of the competence formation levels of the Bachelors of Informatics in using OSNT are defined. They are:

- *professional and cognitive criterion* – possession of fundamental knowledge on using OSNT required for the future professional activity;
- *professional and activity criterion* – independent implementation of the formed knowledge and skills on using OSNT in different situations;
- *motivational and objective criterion* – existence of developed informative motivation of OSNT implementation, due to the professional interests and desire for self-improvement;
- *ethical* – formation of correct behavior in the open educational environment and

awareness of the risks of using OSNT while learning.

With the aim of formation of Bachelors of Informatics competence in the use of OSNT the following objectives were set: (i) to define the level of Bachelors of Informatics competence in the use of OSNT; (ii) to define the possibility of the use of OSNT in future activity of Bachelors of Informatics; (iii) to check experimentally the efficiency of the offered methodology of the use of OSNT in Bachelors of Informatics studies in the university training process; and (iv) to identify the growth dynamics of formation of Bachelors of Informatics competence in relation to the use of OSNT on practice.

The experimental study was performed to demonstrate growth dynamics of Bachelors of Informatics competence in the use of OSNT. The experiment involved 240 students of Ivan Franko State Pedagogical University in Drohobych. The main directions of the experiment were as follows: (i) development and implementation of teaching materials on OSNT in the educational process of Drohobych Ivan Franko State Pedagogical University; (ii) using OSNT in teaching the course of Organizational Informatics for the Bachelors of Informatics (development of the laboratory workshop, methodological guidelines for practical classes and methodical materials for independent work, theoretical and practical tasks for control).

It is advisable to train the Bachelors of Informatics according to the methodology using OSNT. The aim of training is to teach the Bachelors of Informatics to use OSNT and form the corresponding competence. The content of training is the improvement of IT courses using OSNT (based on the content of the course Organizational Informatics).

The students in the experimental group (EG) were trained in accordance with the developed methodology of OSNT while those in control group (CG) in accordance with traditional methodology.

The competence of Bachelors of Informatics in using the OSNT can be demonstrated as a possible way of improving such criteria as: professional and cognitive; professional and activity; motivational and objective; ethical.

The competence level of the Bachelors of Informatics in using the OSNT was verified according to the professional and cognitive criteria by analyzing the results of practical tasks implementation in the course of Organizational Informatics.

During practical classes students get acquainted and learn to work with OSNT, namely: distance education technologies (based on Moodle), research-and-development automation technologies (based on Google Drive), correlation support using mobile devices (based on Google Calendar), electronic social networks (based on Facebook), digital libraries (based on the electronic library of the National Academy of Pedagogical Sciences of Ukraine), educational (based on Wolfram|Alpha) and popular science (based on Wikipedia) information networks, etc. As a result of training by experimental methodology the number of students in EG increased compared to CG with high (14.1% of AG and 5.4% of CG) and sufficient (33.6% of EG and 23.2% CG) levels of competence in using OSNT (Fig. 1, table 2).

Table 2.

The comparison of the competence level of Bachelors of Informatics in using OSNT by the professional and cognitive criteria

Level		<i>low</i>	<i>middle</i>	<i>sufficient</i>	<i>high</i>
CG	person	18	62	26	6
	%	16,07	55,36	23,21	5,36
EG	person	12	55	43	18
	%	9,38	42,97	33,59	14,06

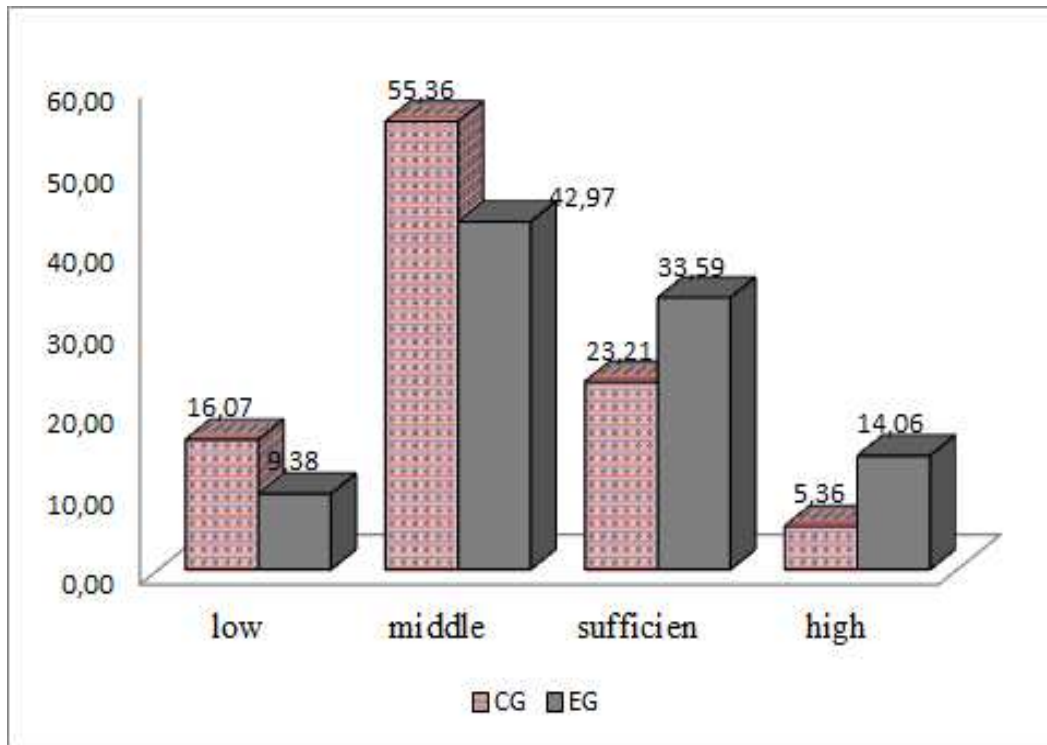


Fig. 1. Dynamics of competence change in using OSNT by professional and cognitive criterion

The determination of the changes of the Bachelors of Informatics competence level in using OSNT by professional and activity criteria occurred through the analysis of the results of projects to be done independently. The independent work of students involves the research of OSNT, namely, browsers, search engines and geoinformation services, VoIP telephony tools (based on Skype), video hosting services (based on YouTube), online translators, electronic textbooks on open access.

The results shown in table 3 and Fig. 2 reveal the increase in the number of students using OSNT to fulfill the tasks to be done independently, namely: high (16,4% AG and 8,9% of CG) and sufficient (35,2% of AG and 21,4% of CG) levels.

Table 3.

The comparison of the competence development level of Bachelors of Informatics in using OSNT by the professional and activity criterion

Level		<i>low</i>	<i>middle</i>	<i>sufficient</i>	<i>high</i>
CG	person	20	58	24	10
	%	17,86	51,79	21,43	8,93
EG	person	12	50	45	21
	%	9,38	39,06	35,16	16,41

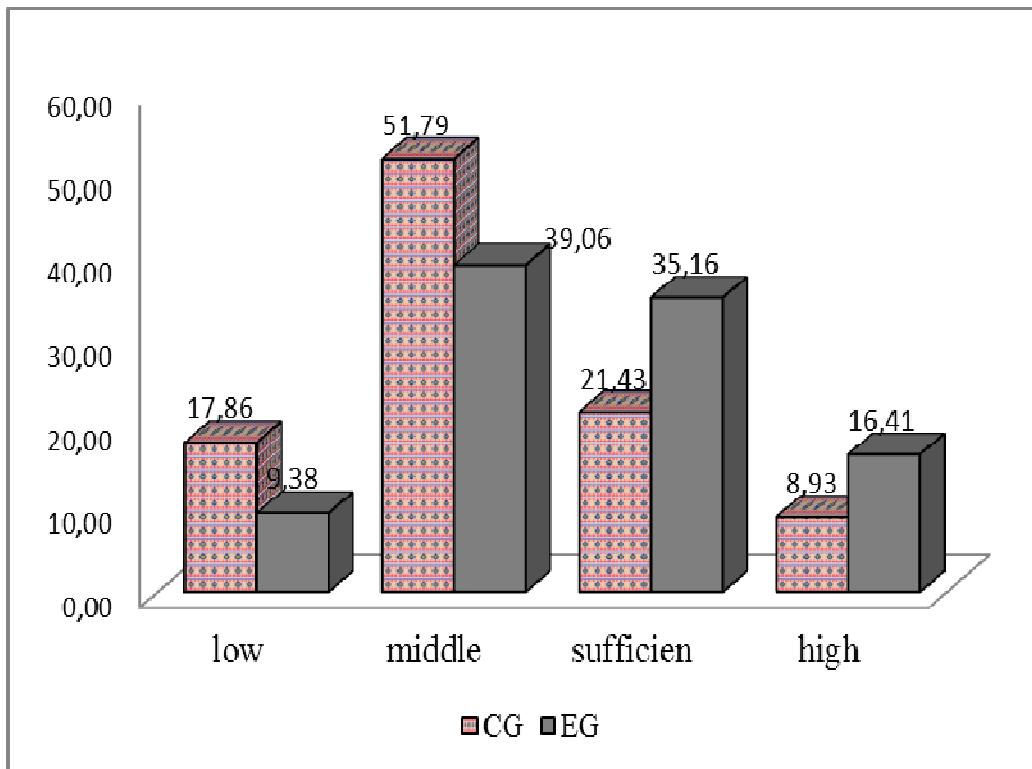


Fig. 2. Dynamics of competence growth in using OSNT by professional and activity criterion

To determine the influence of the OSNT using methodology for Bachelors of Informatics on the competence formation in using OSNT by motivational and objective criterion the student survey was carried out, the results of which are presented in table 4.

Table 4.

Competence development in using OSNT by Bachelors of Informatics by motivational and objective criterion

No.	Question	Students (%)	
		CG	EG
1.	<i>What motivates you most to use open systems network technologies in educational process?</i>		
	<i>a) the desire to develop my own IC competence;</i>	22,3	27,3
	<i>b) the desire to obtain live information in the learning process;</i>	21,4	28,9
	<i>b) interest in working with diverse technologies on open access;</i>	33,9	31,3
	<i>z) the desire to avoid trouble from the teacher;</i>	17,9	7,0
	<i>d) the demand of teachers;</i>	4,5	3,9
	<i>e) other.</i>	0,0	1,6
2.	<i>In your opinion, the ability and skills to apply open systems network technologies for your future professional activity are:</i>		
	<i>a) necessary;</i>	22,3	35,9
	<i>b) desirable;</i>	40,2	49,2
	<i>e) not obligatory?</i>	37,5	14,8

As can be seen, the students point out different motives for using OSNT. 77.7% of students in CG and 87.5% in EG – cognitive motives; 22.3% of students in CG and 10.9% in EG – social motives. A small percentage of the students in EG (1.6 percent) have formed their own answer as to the motive for using OSNT, for example: flexibility, speed and operational efficiency, availability at any time (table 5, Fig. 3).

Table 5.

The comparison of the competence level in using OSNT on by Bachelors of Informatics by motivational and objective criterion

Level		<i>low</i>	<i>middle</i>	<i>sufficient</i>	<i>high</i>
CG	person	25	47	23	17
	%	22,32	41,96	20,54	15,18
EG	person	17	39	44	28
	%	13,28	30,47	34,38	21,88

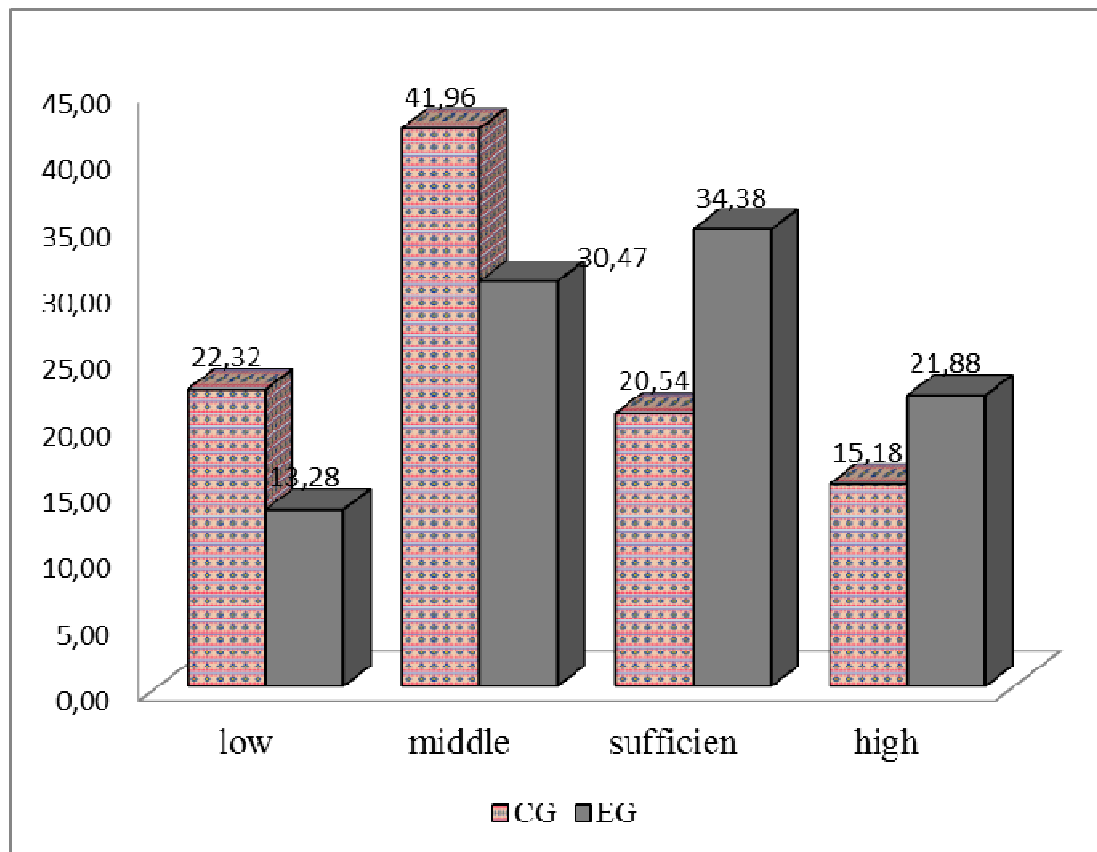


Fig. 3. Dynamics of competence growth in using OSNT on motivational and objective criterion

To identify changes in the competence level of Bachelors of informatics in using OSNT by ethical criterion the analysis of student projects in relation to the risks of OSNT using was conducted. As a result, it was necessary to form the "Code of the safe use of OSNT". It is known that there are a number of risks in using OSNT, in particular related to the protection of personal data, the possibilities of copyright violations and plagiarism, ethical and social nature limitations etc.

The results of the projects implementation give the possibility to observe students awareness of the risks of using OSNT not only within academic disciplines, but also in the preparation of reports and essays, term papers, theses and dissertations, during participation in the events of the competitive nature (olympiad competitions, contests), in social networks. The dynamics of changes in the competence levels in using OSNT by the ethical criterion is positive (table 6, Fig.4): in the EG the number of students with high (15,6%) and sufficient (53,9%) competence development levels in using OSNT increased.

Table 6.

The comparison of the competence level of Bachelors of Informatics in using OSNT by ethical criterion

Level		<i>low</i>	<i>middle</i>	<i>sufficient</i>	<i>high</i>
CG	person	12	40	52	8
	%	10,71	35,71	46,43	7,14
EG	person	4	35	69	20
	%	3,13	27,34	53,91	15,63

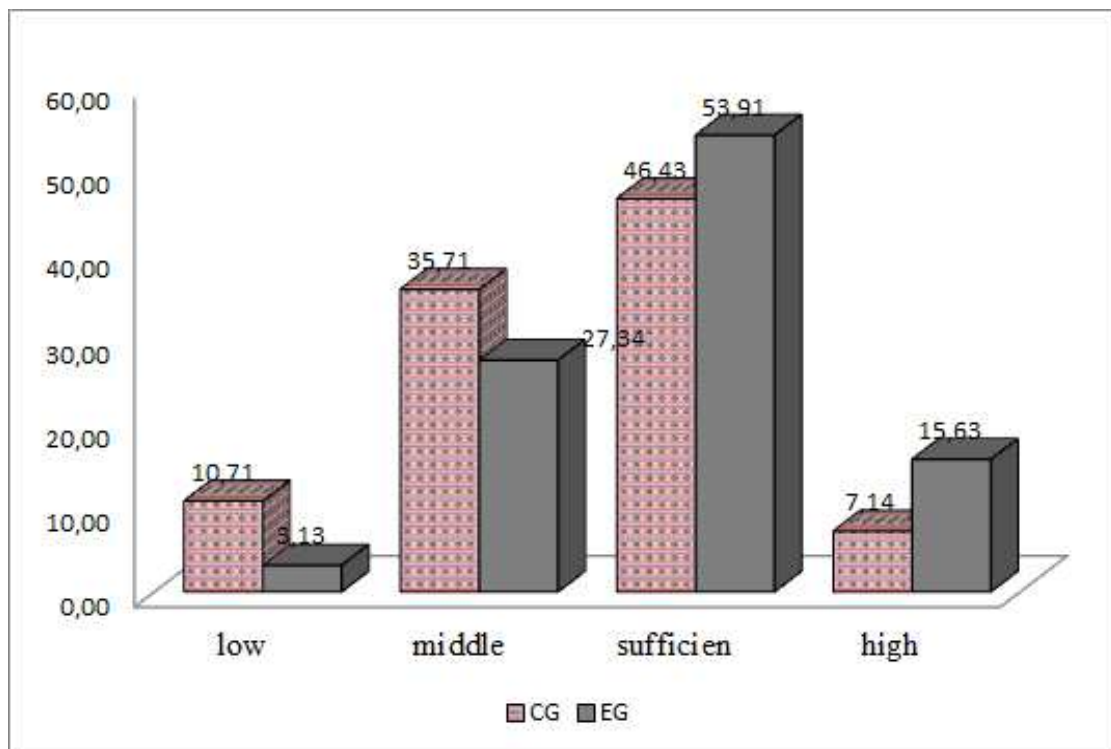


Fig. 4. Dynamics of changes in the competence levels in using OSNT by the ethical criterion

The conducted research showed that the dynamics of changes in the competence development levels of Bachelors of Informatics in using OSNT by the specified criteria demonstrates a positive tendency (Fig. 5, 6).

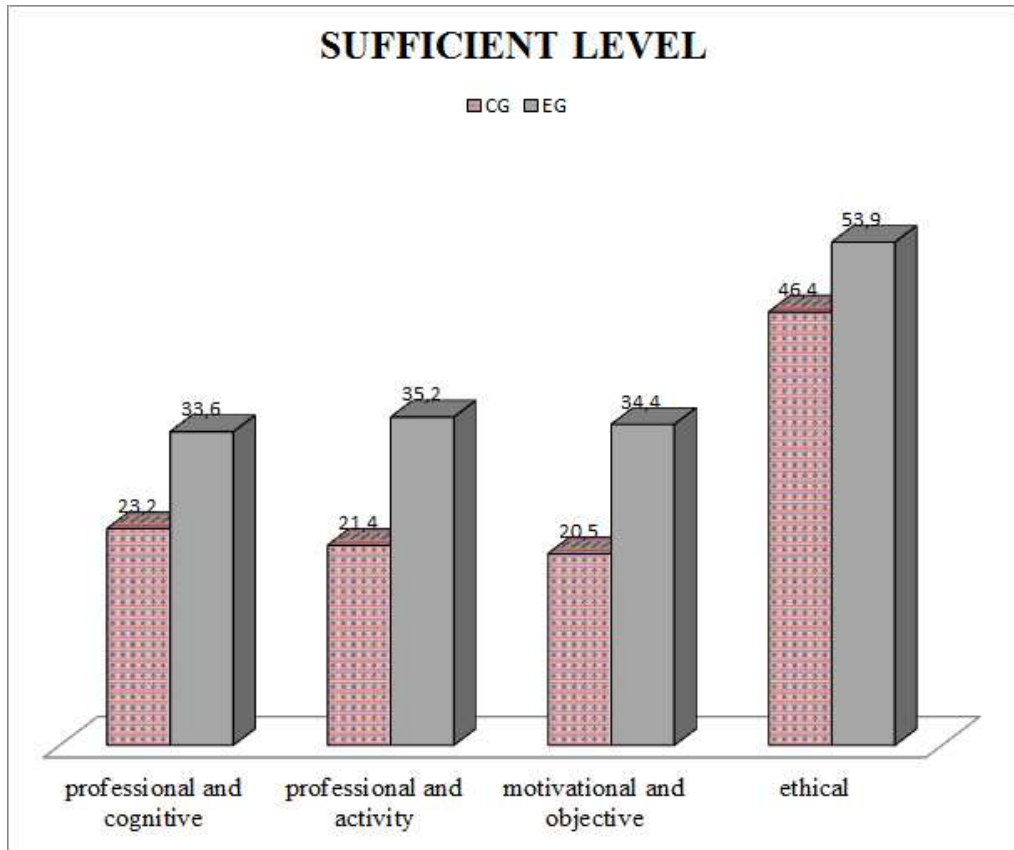


Fig. 5. Dynamics of changes of sufficient competence level of Bachelors of Informatics in using OSNT by criteria

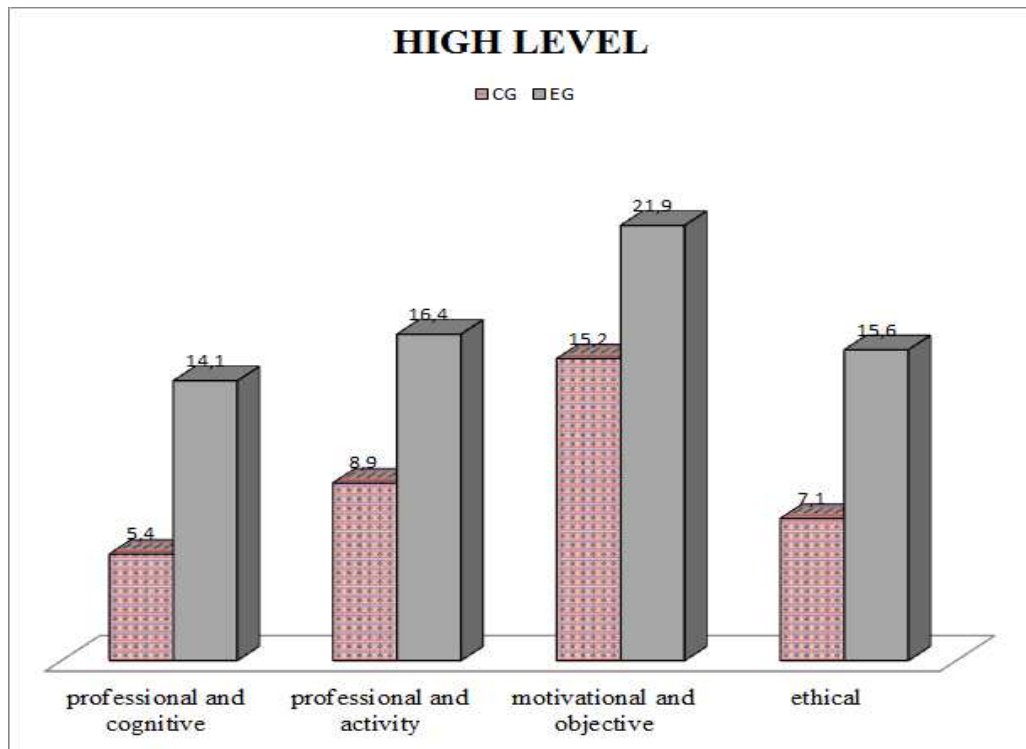


Fig. 6. Dynamics of changes of high competence level of Bachelors of Informatics in using OSNT by criteria

To prove the drawn conclusions and to examine the statistical differences of the students in the control and experimental groups Pearson criterion was chosen (χ^2). In our example the requirements are observed regarding the application of criteria for processing results of the pedagogical experiment. It should be checked if the difference between the distributions of the values of the competence formation levels of Bachelors of Informatics in using OSNT according to the developed criteria of the control ($n_1 = 112$) and experimental samples ($n_2 = 128$) is statistically significant ($i = 1,2,3,4$).

The value of χ^2 is calculated using formula [5, p. 101]:

$$T_{\text{excn}} = \frac{1}{n_1 \cdot n_2} \sum_{i=1}^C \frac{(n_1 \cdot O_{2i} - n_2 \cdot O_{1i})^2}{O_{1i} + O_{2i}},$$

where

O_{1i} – the number of participants in the control group, which belong to the i level;

O_{2i} – the number of participants in the experimental group, which belong to the i level;

C – the number of levels. In this case $C = 4$.

Let α be the set significance level. In this case the value of T , obtained in the experiment, should be compared with the critical value found by the table [5, p. 130], taking into account the number of the degrees of freedom (in our case $v=C-1=3$) and significance level $v=95\%$ ($\alpha=0,05$). Here is the critical value of $T_{cr}=7,815$. Having found by the formula the values of competence levels of Bachelors of Informatics in using OSNT T_{exp} according to the developed criteria, it can be confirmed that the examples for experimental and control groups have statistically significant differences (table 7):

- professional and cognitive criterion: $T_{\text{exp}} = 10,788$ and $T_{\text{exp}} > T_{cr}$ ($10,788 > 7,815$);
- professional and activity criterion: $T_{\text{exp}} = 11,873$ and $T_{\text{exp}} > T_{cr}$ ($11,873 > 7,815$);
- motivational and objective criterion: $T_{\text{exp}} = 10,519$ and $T_{\text{exp}} > T_{cr}$ ($10,519 > 7,815$);
- ethical criterion: $T_{\text{exp}} = 10,846$ and $T_{\text{exp}} > T_{cr}$ ($10,846 > 7,815$).

This means that the distribution of competence levels in using OSNT according to the criteria differ in the control and experimental groups. So, the alternative was assumed – the higher competence level of Bachelors of Informatics in using OSNT is the result of the proposed method implementation.

Table 7.

The dynamics of competence development levels of Bachelor of Informatics in using OSNT by criteria

Criteria	Groups	Levels				T_{exp}
		<i>low</i>	<i>middle</i>	<i>sufficient</i>	<i>high</i>	
professional and cognitive	EG	12	55	43	18	10,788
	CG	18	62	26	6	
professional and activity	EG	12	50	45	21	11,873
	CG	20	58	24	10	
motivational and objective	EG	17	39	44	28	10,519
	CG	25	47	23	17	
ethical	EG	4	35	69	20	10,846
	CG	12	40	52	8	

3. THE CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

So, OSNT are constantly improving, and their use in the educational process of the higher educational institutions is a relevant and necessary task that requires scientific substantiation and description of the optimal ways of social and pedagogical support. OSNT selection for the higher educational institutions should be performed according to the following characteristics: (i) management supporting; (ii) commitment to the end-user; (iii) establishment of three-dimensional interaction; (iv) realization of the implementing tasks; and (v) user service.

The results of the implementation of the developed methodology of using OSNT in training the Bachelors of Informatics confirm its effectiveness. This provides the opportunity to recommend the methodology for wide implementation in the education of Bachelors of Informatics in Ukrainian higher educational institutions, in particular, to form the competence in using OSNT. The conducted experimental research attests the positive dynamics of Bachelors of Informatics growth of competence in using OSNT.

The undertaken study does not exhaust all aspects of the identified problems. Some items need further investigation. They are as follows: (i) OSNT use in teaching students of other training programs, particularly in the teaching of computing disciplines, minimization of OSNT hazardous effect on the user; and (ii) improvement of the teaching and educational support staff's skills regarding OSNT implementation.

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ФОРМУВАННЯ КОМПЕТЕНТНОСТІ БАКАЛАВРІВ ІНФОРМАТИКИ ЩОДО ВИКОРИСТАННЯ МЕРЕЖНИХ ТЕХНОЛОГІЙ ВІДКРИТИХ СИСТЕМ

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Анотація. У статті розглядається проблема використання мережних технологій відкритих систем (МТВС) для підготовки майбутніх бакалаврів інформатики. Обґрунтовано, що вибір МТВС для вищих навчальних закладів повинен здійснюватися відповідно до таких характеристик, як підтримка управління, зобов'язання перед кінцевим користувачем, встановлення тривимірної взаємодії, реалізація виконавчих завдань та служба користувача. Визначено критерії, показники та рівні компетентності бакалаврів інформатики щодо використання МТВС. Описано основні етапи педагогічного експерименту щодо використання МТВС для майбутніх бакалаврів інформатики. Експериментальне впровадження результатів дослідження показало, що застосування спеціальної методики у навчанні бакалаврів інформатики сприяє формуванню компетентності щодо використання МТВС.

Ключові слова: відкрита освіта; мережні технології відкритих систем; бакалавр інформатики; компетентність щодо використання МТВС.

ФОРМИРОВАНИЕ КОМПЕТЕНТНОСТИ БАКАЛАВРОВ ИНФОРМАТИКИ ПО ИСПОЛЬЗОВАНИЮ СЕТЕВЫХ ТЕХНОЛОГИЙ ОТКРЫТЫХ СИСТЕМ

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Аннотация. В статье рассматривается проблема использования сетевых технологий открытых систем (СТОС) для подготовки будущих бакалавров информатики. Обосновано, что выбор СТОС для высших учебных заведений должен осуществляться в соответствии с такими характеристиками, как поддержка управления, обязательства перед конечным пользователем, установление трехмерной взаимодействия, реализация исполнительных задач и служба пользователя. Определены критерии, показатели и уровни компетентности бакалавров информатики по использованию СТОС. Описаны основные этапы педагогического эксперимента по использованию СТОС для будущих бакалавров информатики. Экспериментальное внедрение результатов исследования показало, что применение специальной методики в обучении бакалавров информатики способствует формированию компетентности по использованию СТОС.

Ключевые слова: открытое образование, сетевые технологии открытых систем, бакалавр информатики, компетентность по использованию СТОС.

