ASPECTS OF TRAINING BACHELORS IN VOCATIONAL EDUCATION (COMPUTER TECHNOLOGIES)

Viktoriia Tkachuk
Associate of the Department of Engineering Pedagogy and Language Training
Kryviy Rih National University,
e-mail: viktoriya.tkachuk@gmail.com, orcid.org/0000-0002-5879-5147, Ukraine
Tetiana Sulyma
Associate Professor, PhD, Kryviy Rih National University,
e-mail: sts.1811@ukr.net, orcid.org/0000-0002-8869-040X, Ukraine
Olena Tarasova
Associate Professor, PhD, Kryviy Rih National University,
e-mail: tarasova1509@rambler.ru, orcid.org/0000-0002-0756-4947, Ukraine
Svitlana Khotskina
Associate Professor, PhD, Kryviy Rih National University,
e-mail: khotskinasv@ukr.net, orcid.org/0000-0002-0297-930X, Ukraine

Abstract. The present multi-aspect research into training future vocational teachers of the first (bachelor) cycle of higher education and the increased status of forming a creative mobile specialist on the labour market is focused on regulatory content aspects to ensure high-quality vocational training at Ukraine's universities. The number of licensed, state-ordered and enrolled students specializing in vocational education (Speciality 015) for the last three years is compared. The research reveals the essence of integrated vocational and pedagogical training of students pursuing a bachelor's degree in Speciality 015 "Vocational Education (Computer Technologies)".

The educational programme of training contains 240 credits. There are described specialized laboratories for training students pursuing a bachelor's degree in Speciality 015 "Vocational Education (Computer Technologies)" at Kryvyi Rih National University. There are provided programme results of training students pursuing a bachelor's degree in Speciality 015 "Vocational Education (Computer Technologies)" and relevant competences. To diagnose maturity levels of each competence (low, medium, high) of future teachers of vocational training (IT specialists), cognitive, operation-technological, axiological and motivational criteria are determined. Special attention is paid to a number of topical problems of updating the content of specialists' training in the field under study.

Keywords: bachelors training, vocational education, computer technologies, future vocational teachers, IT specialists.

DOI: http://dx.doi.org/10.23856/3211

Thematic justification

At present, there is a prevailing crisis of vocational education caused by modern global problems and challenges due to the demographic bust, increased labour migration, growing social interests of young people, availability of educational opportunities in foreign countries, escalating influence of social networking on vocational trends and school leavers' career choices.

Initial statements of the research are grounded on conceptual ideas of the state regulatory documents covering basic points of implementing educational activity at modern higher school (the State national programme "Education. Ukraine of the 21st century", the Act of Ukraine "On Higher Education", the Concept of developing vocational education and training in Ukraine (2010-2020); the National doctrine of education development; the National strategy of education development in Ukraine 92012-2021); conceptual principles of developing pedagogical education of Ukraine and its integration into the European educational space, etc.

The project "Modern professional education: conceptual principles of reforming professional education of Ukraine" states that, for the last decades, the prestige of vocational education in society has gradually decreased because of:

– absence of investments in vocational education updating;

– contradiction of demand and supply, quality of staff training;

– imperfection of the system of professional orientation and career consulting of young people and adults *(Modern vocational education: conceptual principles of reforming Ukraine's vocational education (project), 2018)*.

Yet, the problem can be solved by implementing the conceptual principles in 2018-28 starting from adoption of the latest wording of the Act of Ukraine "On Vocational (Vocational and Technical) Education" on up to integration of Ukraine's vocational education into the European educational space through observing the three major components of modern vocational education:

– decentralization of management and financing of technical and vocational education;

– social partnership in the sphere of vocational education and training and on the labour market;

– quality of vocational education *(On approval of the field-specific Concept of developing continuous pedagogical education, 2013; The Law of Ukraine "On Vocational (Technical and Vocational) Education", 1998)*.

Ukrainian scholars are investigating various aspects of the problem of vocational training at national higher school, namely: vocational training at higher educational institutions (S. Karaman, S. Martynenko, O. Matviienko, O. Mytnyk, N. Moiseiuk, O. Oleksiuk, O. Romanovskyi, S. Sysoieva, M. Chobitko); continuous vocational training (S. Honcharenko, N. Nychkalo, L. Khorizha); formation of future specialists' professional competence (N. Bibik, S. Kravets, O. Pometun, O. Savchenko, L. Sushentseva, V. Yahupov).

Improvement of the structure of teachers training and retraining is a priority for developing continuous pedagogical education aimed at introducing acmeological and axiological principles of teachers training, forming motivation and creating conditions for their education and self-development during their professional activity, updating the training content, forms, methods and technologies to meet the demands of civil multicultural information society *(On approval of the field-specific Concept of developing continuous pedagogical education, 2013)*.

It becomes essential to create a system of ensuring the quality of vocational education which encapsulates informatization, development of pedagogical software, provision of access to world information resources, improvement of the system of pedagogical staff training, retraining and further training *(Modern vocational education: conceptual principles of reforming Ukraine's vocational education (project), 2018)*.

Comparison of the licensed, state-ordered and enrolled applicants for Speciality 015 "Vocational Education" at higher educational institutions of Ukraine is provided in Table 1.

Table 1

Comparison of the licensed, state-ordered and enrolled applicants f or Speciality 015 "Vocational Education"

Higher education institution of Ukraine	2016				2017				2018			
	L	S	E	Δ	L	S	E	Δ	L	S	E	Δ
Kyiv National University of Construction and Architecture	30	10	11	1	15	0	7	7	30	30	0	30
International University of Economics and Humanities named after Academician Stepan Demianchuk	50	0	1	1	0	0	0	0	0	0	0	0
Vynnytsia Mykhailo Kotsiubynskyi State Pedagogical University	30	7	9	2	25	0	9	9	120	60	60	60
Rivne State University of Humanities	25	8	8	0	25	0	8	8	50	25	25	0
Pavlo Tychina Uman State Pedagogical University	50	10	22	12	70	0	6	6	70	50	20	30
Lutsk National Technical University	40	15	14	-1	40	0	9	9	120	60	60	0
Kryvyi Rih National University	15	10	10	0	15	12	0	12	15	12	0	12
Berdiansk State Pedagogical University	150	10	19	9	150	0	12	12	250	150	100	50
Ukrainian Engineering Pedagogics Academy	60	18	22	4	25	0	13	13	120	60	60	0
National Pedagogical Dragomanov University	50	5	6	1	25	0	4	4	50	50	-	50
Ternopil Volodymyr Hnatiuk National Pedagogical University	70	30	29	-1	70	0	26	26	140	35	35	0
Educational-Research Vocational-Pedagogical Institute (Artemivsk, Sloviansk) of the Ukrainian Engineering Pedagogical Academy	50	0	2	2	25	0	0	0	100	50	50	0
Total	620	123	153	30	485	0	103	103	1065	582	410	232

Source: (Informational system Enrolment Competition, 2018)

Notes: L is the licensed number of students, S is the state-ordered number, E is the number of enrolled students, Δ=E-S is the exceeding number as compared to the state-ordered one.

People of appropriate vocational and pedagogical training and characterized by high moral and physical standards are capable of working at institutions of vocational (technical and vocational) training as teaching employees *(The Law of Ukraine "On Vocational (Technical and Vocational) Education", 1998: art. 45).*

After graduating as teachers of vocational training (IT specialists), graduates can teach IT subjects at institutions of vocational (technical and vocational) education and colleges. Besides, the Act of Ukraine "On Vocational (Technical and Vocational) Education" states that industrial and service specialists having a university degree can be appointed teaching employees and get an appropriate psychological and pedagogical training later *(The Law of Ukraine "On Vocational (Technical and Vocational) Education", 1998: art. 45).*

During their training, students specialize in both pedagogy and IT engineering (Table 2). They acquire engineering IT competences, skills of creating and using various computer technologies. Their pedagogical and psychological training is thorough and profound reinforced by teaching methods of vocational subjects enabling them to teach computer and psychological-pedagogical subjects at vocational institutions.

At Kryvyi Rih National University, students pursuing a bachelor's degree in Speciality 015 "Vocational Education (Computer Technologies)" receive profound theoretical and practical training in:

– programming in various environments;
– creating information systems for management and training;
– working with intellectual systems including expert ones;
– working with network and Internet technologies, Web-design;
– working with multimedia, means of large-scale demonstration and presentation;
– working with computer-aided design systems;
– general and developmental psychology, labour psychology;
– methods of managing and conducting IT classes at vocational institutions.

Students are capable of creating and using IT technologies for management and training, conveying knowledge of the psychological-pedagogical and engineering fields to students of vocational institutions and universities.

Table 2

Jobs that can be obtained by students of Speciality 015 "Vocational Education (Computer Technologies)"

As specialists in managing technological processes	As specialists of education
– a programming engineer; – a computer operator – an electronics engineer – a designer of computing systems and software; – a programming specialist; – an executive assistant, an administrative secretary.	– a teacher of Computer Technologies at vocational institutions; – a first-class education coordinator; – an assistant; – a junior researcher; – a senior laboratory assistant of the training process; – a head of a training laboratory; – an instructor (foreman) of industrial training; – methodologist.

Source: *(Information system Enrolment Competition, 2018; Ministry of education presented Conceptual principles of reforming Ukraine's vocational education, 2018)*

The training content designed for students of Speciality 015 "Vocational Education (Computer Technologies)" is described in the educational programme (240 credits in total, 40 academic hours per credit).

The educational programme contains subjects, course papers, practices and qualification papers (Table 3).

Table 3

Components of the educational programme of Speciality 015 "Vocational Education (Computer Technologies)"

Code	Components of educational programme	Number of credits	Form of final control
Compulsory components (CC)			
CC 1.	Informatics and Computing Machines	7	Examination/Credit
CC 2.	History of Ukraine and Ukrainian Culture	3	Examination
CC 3.	Ukrainian Language (for specific purposes)	3	Examination
CC 4.	Foreign Language	6	Examination/Credit
CC 5.	Philosophy	3	Examination
CC 6.	Physical Training	6	Credit
CC 7.	Higher Mathematics	14	Examination
CC 8.	Physics	6.5	Examination/Credit
CC 9.	Engineering and Computer Graphics	3	Credit
CC 10.	Psychology	20	Examination/Credit, Course Paper
CC 11.	Methods of Vocational Training	13	Examination, Course Paper
CC 12.	Vocational Pedagogy	13.5	Examination/Credit, Course Paper
CC 13.	Basic Principles of Scientific and Pedagogical Research	3	Credit
CC 14.	Theoretical and Legal Principles of Education and Introduction to Speciality	4	Credit
CC 15.	Pedagogical Excellence	9	Examination/Credit
CC 16.	Conflictology in Professional Activity	4	Credit
CC 17.	Training Technologies in Modern Education	5	Credit
CC 18.	Substitutability, Standardization and Technical Measurements	3	Credit
CC 19.	Теорія автоматичного управління Theory of Automatic Control	3.5	Credit
CC 20.	Computer-Based Systems of Administration	5.5	Examination
CC 21.	Life Safety and Principles of Health and Safety	3	Examination
CC 22.	Enterprise Economy and Marketing	3	Credit
CC 23.	Educational Practice	4.5	Credit
CC 24.	Technological Practice	6	Credit
CC 25.	Pedagogical Practice	4.5	Credit
CC 26.	Bachelor's Qualification Paper	12	Examination
Compulsory components, total:		168 credits	
Selective components of the educational programme			
Selective Block (SB) 1 (015 "Vocational Education (Computer Technologies)")			
SB.1.1.	Business Foreign Language	3	Credit
SB 1.2.	IT Ergonomics	4	Examination
SB 1.3.	Computer Document Studies	6	Examination
SB 1.4.	Computer Design and Multimedia	6	Examination
SB 1.5.	Database Management Systems	4	Credit
SB 1.6.	Programming Technology	4	Credit
SB 1.7.	Applied and Web-programming	12.5	Examination/Credit, Course Project
SB 1.8.	Computer technologies in Training	9.5	Examination/Credit
SB 1.9.	Computer Networks and Data Security	7	Examination
SB 1.10.	Computer Repair and Updating	3	Credit
SB 1.11.	Computer Practicum	8	Examination
SB 1.12.	Design and Operation of Information Systems	5	Examination
Selective components, total		72	
Total number of credits		240	

Provision of high-level training at Kryvyi Rih National University

To provide high-level training at Kryvyi Rih National University, classes in the subjects specified in Table 3 are conducted in specialized laboratories, namely:

– the EduNet Laboratory provides a laboratory practicum in Automatic Control Systems. It is intended for studying modern automation means of processes and network technologies. The equipment made by Phoenix Contact enables managing various control systems from household simple electric appliances to complex automation systems of large-scale enterprises, industrial in particular;

– the Computer Networks Laboratory provides a laboratory practicum in the subject "Computer Networks and Data Security". It is equipped with specialized up-to-date telecommunication equipment by Cisco, D-Link, Vin et. On the basis of this laboratory, the Network Academy CISCO has been created and the subjects dealing with network technologies have been integrated into training;

– the Laboratory of FESTO-Based Pneumatics and Robotics Elements provides a laboratory practicum in the subject "Theory of Automatic Control". The laboratory is equipped with modern equipment by Festo, Mitsubishi, Schneider Electric, OBEH;

– the Laboratory of Technological Measurements and Technical Means of Automation provides a laboratory practicum in the subject "Substitutability, Standardization and Technical Measurements". The laboratory is equipped with modern equipment by Schneider Electric (software logic controller of Modicon M340, M238 series, frequency transformers Altivar 312), Danfoss;

– the Laboratory of Automatic Control Systems Simulation provides a laboratory practicum in the subject "Design and Operation of Information Systems". The laboratory is equipped with modern computers enabling students to work not only in laboratory stands, but also in specialized software packages like MATLAB, MultiSim, LabView, MathCAD, as well as in Microsoft Visual Studio;

– the Laboratory of Automation Systems on the Basis of Schneider Electric Controllers provides a laboratory practicum in the subject "Computer Repair and Updating". The laboratory is equipped with modern equipment by Schneider Electric (Twido, Modicon TSX Micro, Modicon TSX Premium, ILC Zelio, Magelis, Altivar, Altistart). The Authorized Training Centre of Schneider Electric Ukraine - Automation Tools and Control Systems of Mechanisms and Processes - has been created on the basis of this laboratory. After completing the course, students are awarded a professional advancement certificate and a training certificate from Schneider Electric;

– the Laboratory of Automation Systems Based on Industrial Controllers and Visualization Means provides a laboratory practicum in the subjects "Computer Practicum", "Applied and Web-Programming" and "Programming Technology". The laboratory is equipped with equipment by Schneider Electric including industrial controllers Premium, sensor boards Majelis XBT GT and alphanumeric boards Majelis XBT R designed to visualize technological processes. The following license software has been installed: Unity Pro, SoMachine to design programmes; Vijeo Designe, Vijeo Designer Lite to design man-machine interface by using operator boards; Vijeo Citect to design supervisory control and data acquisition systems (SCADA); Wonderware to design automatic control systems at industrial enterprises – manufacturing execution systems (MES).

According to the Temporary Standard of Ukraine's higher education concerning a bachelor degree of Knowledge Area of Education 01, Speciality 015 "Vocational Education (Computer Technologies)", the training programme is aimed at expected application of acquired competences through forming general and professional competences in psychological, pedagogical, information systems and technologies facilitating graduates' social and professional stability and mobility on the labour market; obtaining vocational education which enables graduates to deal with ICT designing, introduction and investigation in various areas of activity, the national economy and industry *(Bakum et al., 2016)*.

Programme results of training students pursuing a bachelor's degree in Speciality 015 "Vocational Education (Computer Technologies)" are expressed in the following competences:

1. The ability to apply knowledge of fundamental, general engineering, social, humanitarian and field-specific (psychological and pedagogical) subjects to solving training problems designed for future professional activity.
2. The ability to create educational and methodological complexes and projects for a number of subjects (educational, transdisciplinary, walkthrough).
3. The ability to design field-specific activity and apply general and specific software.
4. The ability to design a problem system for pedagogical situations to develop cognitive abilities.
5. The ability to control training situations by ICT means.
6. The ability to integrate IT means and resources in the educational process by choosing necessary materials, multimedia and appropriate methods of their relevant use.
7. The ability to demonstrate knowledge of modern technologies to introduce them in professional activity.
8. The ability to use basic knowledge of Informatics and modern ICT, skills of programming and using programming means, secure operation in computer networks, abilities to create databases, demonstrate skills of designing algorithms and software to realize design tasks and teach IT subjects.
9. The ability to give reasons and substantiate the choice of soft- and hardware means to create ICT by analyzing their properties, purposes and technical characteristics and considering system requirements and operation conditions; skills of adjusting soft- and hardware IT means.
10. The ability to take part in ICT designing, have basic knowledge of the content and design rules, composition and procedure of design performance considering requirements of relative regulatory and legal standards.
11. The ability to understand and consider social, environmental, ethical, and economic aspects, requirements of labour safety, industrial sanitation, fire codes and available state and international standards while determining professional problems *(Tkachuk, 2016)*.

The **criterion aspect of evaluating** ICT competences is of primary importance among other programme results of training vocational teachers (IT specialists).

The criterion aspect of evaluating ICT competences. To diagnose the maturity rate of competences of future specialists of Speciality 015 "Vocational Education (Computer Technologies)", there are determined evaluation criteria of each ICT- competence (cognitive, operation-technological, evaluative-motivational) according to three levels (low, medium, high). To study each ICT-competence, a relative matrix has been built which includes criteria evaluating each level of maturity of future vocational teachers' (IT specialists') ICT competences (Table 4).

Table 4

Criteria, levels and indices of evaluating future vocational teachers' (IT specialists') abilities

Levels Criteria	low	medium	high
Cognitive	The graduate is aware of applying Informatics to satisfying personal and social information needs	The graduate has substantial knowledge of Informatics applied to satisfying personal information needs and ideas of satisfying information needs of society	The graduate has substantial knowledge of Informatics applied to satisfying information needs of citizens and society by providing managerial, legal, political, social, economic, scientific, technical and industrial processes
Operation-techno-logical	The graduate explains personalized applications of Informatics, has problems in defining and explaining their social consequences	The graduate explains and detects personal applications of Informatics, defines some social consequences, provides their known explanations	The graduate detects, evaluates and explains various applications of Informatics and its social consequences
Evaluative-motiva-tional	The graduate is interested in applications of Informatics to satisfying personal information needs without considering provision of needs in managerial, legal, political, social, economic, scientific, technical and industrial processes	The graduate observes social and ethical standards of behaviour in information society provided external control	The graduate deliberately observes social and ethical standards of behaviour in information society

Source: (Tkachuk, 2017)

The formed matrices of competences are a means of monitoring formation of students' ICT competences. There are developed methods of evaluating the maturity rate of future vocational teachers' (IT specialists') ICT competences at the initial, minimum-basic, basic, higher, advanced and research levels.

Conclusions

Training of future vocational teachers (IT specialists) is of great importance due to the regulatory content-based aspect reflecting specific development of students' capabilities towards professional and personal formation and self-development. It will enhance future specialists' creative potential and mobility on the labour market in modern conditions of

higher vocational (technical and vocational) school of Ukraine.

References

Bakum Z. P., Khotskina, S. M., Sulyma, T. S., Tkachuk, V. V. (2016). Temporary standard of higher education of Ukraine: Bachelor: Speciality 015 Vocational Education (Computer Technologies). Ministry of Education and Science of Ukraine. Kryvyi Rih: Kryvyi Rih National University. [in Ukrainian].

Bakum, Z. P., Khotskina, S. M., Tkachuk, V. V. (2017). Problems of standardizing higher education in the context of bachelors training in Speciality 015.10 - Vocational education (computer technologies). Engineering and Educational Technologies, 2 (18), 8-19. [in Ukrainian].

Hladchenko, O. V., Khotskina, S. M. (2017). Adaptation aspects of professional formation of university graduates. Methodological Journal. Kryvyi Rih Vocational Mining Technological Lyceum, 3, 16-19. [in Ukrainian].

Information system Enrolment Competition (2018). [Electronic resource]. Retrieved from http://vstup.info/2018/index.html [in Ukrainian].

Khotskina, S. (2018). Methodical aspects of personal work organization in the process of professional education of professional training teachers (as exemplified by study of professional and practical training program). Scientific Journal of Polonia University, 26 (1), 108–116. https://doi.org/https://doi.org/10.23856/2614. [in English].

Ministry of education presented Conceptual principles of reforming Ukraine's vocational education. (2018). Confederation of employers of Ukraine. [Electronic resource]. Retrieved from http://employers.org.ua/news/id1913. [in Ukrainian].

Modern vocational education: conceptual principles of reforming Ukraine's vocational education (project) (2018). Kyiv. [Electronic resource]. Retrieved from https://mon.gov.ua/storage/app/media/gromadske-obgovorennya/2018/05/18/0518-kontseptsiya. doc. [in Ukrainian].

Morkun, V. S., Bakum Z. P., Khotskina, S. M., Tkachuk, V. V. (2015). Training of mining engineer: school - university - enterprise: [monograph]. Kryvyi Rih: Kryvyi Rih National University. [in Ukrainian].

National classifier of Ukraine: Occupational classifier SC 003:2010. (2010). Kyiv: Sotsioform. [in Ukrainian].

On approval of the field-specific Concept of developing continuous pedagogical education (2013). [Electronic resource]. Retrieved from http://osvita.ua/legislation/Ser_osv/36816/. [in Ukrainian].

The Law of Ukraine "On Vocational (Vocational and Technical) Education", 10.02.1998, no. 103/98- VR, with alterations and additions. [Electronic resource]. Retrieved from https://zakon.rada.gov.ua/laws/show/103/98-%D0%B2%D1%80. [in Ukrainian].

Tkachuk, V. V. (2016). Designing professional ICT competences of future engineer-teachers. Information Technologies and Training Means, vol. 53, 3, 123-141. [in Ukrainian].

Tkachuk, V. V. (2017). Diagnostics of maturity level of future IT engineer-teachers' ICT competences. Scientific Notes, 11(II), 201-211. [in Ukrainian].