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INNOVATIVE MODELS OF EDUCATION AND TRAINING OF SKILLED PERSONNEL FOR HIGH TECH INDUSTRIES IN UKRAINE

The problems of development of innovative learning environment of continuous education and training of skilled personnel for high-tech industry are described. Aspects of organization of ICT based learning environment of vocational and technical school on the basis of cloud computing and outsourcing are revealed. The three-stage conceptual model for perspective education and training of workers for high-tech industries is proposed. The model of cloud-based solution for design of learning environment for vocational education and training of skilled workers is introduced.

Ключові слова: e-learning environment; cloud computing; vocational education

Introduction

Availability of engineering staff and workers is an essential part of the productive forces of a society, significant resource of innovative development and competitiveness of ICT industry. Particularly important and difficult task is to prepare skilled workers for high-tech industries. This is one of the most effective ways to ensure positive qualitative changes in the employment structure [3]. Quality of training of personnel directly affects the technological level of production and its competitiveness at the markets of goods and services.

Being a support and a catalyst for innovation, the educational system is designed to respond quickly to new needs and challenges in development of the productive forces of society. This determines the value of innovative technologies in the process of upgrading learning environment of engineering and vocational education.

Problem statement

Now, the problem of training of qualified personnel for IT industry can hardly be taken independently of the processes of innovative development of educational space, which is formed within the school, region, educational system of a country or globally [4, 5]. In this regard, there is a need for fundamental research of possible directions of development of educational environment of educational institutions taking into account the trend of improving ICT innovation and search for new engineering technology and pedagogical and organizational models of personnel training. The main focus is shifting from mass introduction of separate software products to integrated and combined environment supporting distributed network services and cross-platform solutions [4, 10, 11, 12].

Emerging technologies of information and communication networks give a way for implementing of a holistic approach to education and training of personnel. Holistic approach is focused on combining of science and practice, training and production, fundamental and applied knowledge and technological competencies with social and humanitarian. This is a promising direction of development of the productive forces of a region. Therefore, the innovative processes in organization and development of environment for education and training of skilled personnel, new approaches and models of realization are a subject of current research.

Problems of formation of innovative environment of continuous training of workers for IT industries

Today, at the market of information technologies (IT) in Ukraine there are over then two thousand companies, employing more than 150,000 people. According to the analysis of "Annual

Global Outsourcing Report GS100" Ukraine is in the 11th place in the Top-20 of largest world centers of employment of IT industry. By this indicator, Ukraine is the first in the list of countries in Central and Eastern Europe, ahead of Russia, Belarus and Poland. According to expert estimates, the gross income of IT industry in Ukraine is about $ 2 billion with an average annual growth of 30-40%. About 80% of the total profit IT industry falls on export services.

Information and communication technologies (ICT) certainly belong to high technologies and its improvement and widespread adoption is referred within priority areas of scientific and technological development of Ukraine until 2020 by the legislation [2]. To train highly qualified personnel for IT industry is therefore to be a task of particular importance and difficulty, where positive results and gaps in their training are felt the most sharply. Quality of training of such personnel not only affects the competitiveness of individual professionals in the labor market, but also directly affects the scientific and technical level of IT products and its competitiveness on international markets for goods and services, and therefore the overall competitiveness of the economy of Ukraine. It is almost a fundamental possibility of Ukraine's integration into the world economy, the country's national security.

Analysis of problems of training of personnel for IT industry, including materials of relevant industry associations indicates an absence of enough interaction between IT education and the labor market of the sector. Despite of a significant labor market needs in IT specialists, this leads to problems of employment of graduates of IT professions, and in the case of employment - to the long term of adaptation at the workplace, including the necessity of additional, often profound, training almost immediately after hiring. In some cases, a vague idea of future graduates about the real problems and conditions of work at the enterprise of IT industry, their lack of commitment to practical solutions of work situations cause their forced transfer to another place of employment, retraining, changing specialty and that is completely unacceptable, working by other profession or not according to their qualifications.

Thus, according to the mentioned rates of development of the global IT market training of professional staff for domestic IT industry, IT sector of Ukrainian economy – personnel which are mainly prepared within higher and vocational and technical education (universities and vocational schools) - being continuous, based on modern approaches to educational systems design, becomes a key point.

We emphasize that under the present context of economic development an important role of formation of viable productive forces of Ukraine is not only for engineers, but also for skilled workers, especially highly-skilled, without which today it is hardly possible to imagine modern high-tech manufacturing. Rendering of qualitative and quantitative structure of workforce in accord with the trends of social development, its current and future scientific, technical and professional needs is a key issue of development of each socio-economic subsystems of society, the main task of the national VET system.

It is unlikely that the current state of VET could be regarded as fully satisfactory as for needs of IT industry for required number of qualified professionals with appropriate structure and quality of training. The system of training and retraining of employees for IT companies also has not been properly formed.

The processes of education and training of skilled personnel for IT industry should be taken in the context of development of innovative environment of an institution and a region. These processes are concerned to modernization of learning environment in perspective of emerging ICT. Thus there are new models and approaches to personnel training accounting for integration and innovative processes of environment formation and modernization of ICT infrastructure.

For the successful implementation of these objectives, the establishment of learning centers of vocational schools that train workers for IT industry, with the organizational support of local VET authorities, relevant programs should be developed and necessary projects to be implemented. In particular, these programs should include measures to create structures of corporate character (by

the model: school-VET-university- manufacturing), branches in enterprises, business incubators, training and engineering centers and others. As well it is to provide coordination with employer amount of proposals of the state order for training labor for the IT industry.

Cloud Computing as e-Learning Platform for Engineering and Technical Education

New and emerging technologies of information communication networks (ICN) make a great impact on the sphere of education in the whole and on technical and vocational education in particular. The most important feature of the ICT tools of a new age is a degree of adaptation to the learner or customer demands. This makes a reason to impose a notion of *adaptive ICN*. Just ICT tools of adaptive ICN form the technological platform of improvement of the training processes in the most parts of vocational technical school system.

Structure and function of adaptive ICN is forcefully reflected by the concept of electronic data processing based on information technology *cloud computing (CC)*. CC - Cloud Computing, cloud data processing, cloudy (scattered) calculations, clouds, cloud-based approach, the principle, project; cloudy: technology, infrastructure, architecture, system, service, service, proposal, idea, paradigm, the concept and others.

The word and the term "cloud" in the expression CC used as a metaphor, based on the typical image of the Internet or some computer network in a form of a "black box" where all (technical-technological, organizational and functional) details and features of the structure and functioning of actually very complex computer infrastructure are hidden [5].

That is, information technology of cloud computing is a technology of network distributed data processing for which information resources and computing power are flexibly configured according to computer resources and procedural needs of users and are provided according to their requests as Internet services. Thus, the essence of the concept of CC is to provide end users with dynamic access to services, computing resources and applications (including operating systems and ICT infrastructure) over the Internet. This concept significantly alters from the traditional approaches to delivery, management and integration of applications providing conditions for management of a large ICT-infrastructures designed to serve different user groups within a single cloud, allowing users to create and use a lot of individual and collective independent clouds within the total cloud space.

According to this concept a network virtual ICT facilities - virtual network sites (VNS) are formed through a special user interface that is supported by the corresponding system software settings of adaptive ICN. Being a situational component of a logical network infrastructure of ICN with temporary open flexible infrastructure VNS by its construction and lifetime meets personalized needs of the user (individual or group, collective), and formation and use of VNS is supported by the CC-technology. In other words, thanks to special technology of cloud system setup (technological setup of a virtual network infrastructure), information resources, services and computing power contently and geographically distributed in the Internet space are virtually "met" to form virtual network platform (NP) for further use in accordance with the individual or group (collective) targets and needs [5].

That is to say that CC - is information technology supporting NP- virtual structural elements of the adaptive ICN.

Implementation of ICN and cloud computing (CC) in the learning process provides the potential for a fundamental renewal of content-target and technological aspects of the learning process that is realized in enrichment of teaching techniques, training tools and formation of new teaching technologies on this basis.

Especially promising in this respect is the sphere of engineering and technical education because learning occurs mostly in the computer-based environment and requires computer support and facilities that are rather comprehensive and expensive and supposes future professional work in the field of high technologies [6, 7, 12].

Thus there are several trends of e-learning systems for engineering and technical education application where the advantages of cloud computing may be the most visible as it was exposed by certain authors. These trends could be characterized by the following factors [1, 6]:

- Removal or substantial mitigation of the problems of installation, support and maintenance of licensed software, which could be ordered as an Internet service. As this software is used mostly on line it is paid just for what has been used so there is a simplified licensed scheme and possibility to use different types of software that can be compared, chosen, investigated;
- The ability to create and flexibly access and update collections of educational resources due to solving problems of security, authorization and distribution of resources on the basis of unified infrastructure;
- Support of distributed learning processes, due to virtual projects development, for example, by a team of programmers who all have access to a particular environment and program code, devices or laboratories and other facilities;
- Increasing of reliability and reduction of equipment cost while dynamically increasing the hardware resources such as memory, speed, throughput, etc.;
- To improve e-learning organization through support of processes cumbersome calculations and maintain large volumes of data, obtained from students, for example for learning activity monitoring and assessment;
- Providing openness and flexibility of learning using cloud communication services such as email, IP-telephony, instant messaging, teleconferencing and others;
- Variety of ways for e-learning systems and resources collection use being available for different educational divisions or institution integrated on the basis of unite platform.

Aspects of Organization of ICT Based Learning Environment of Vocational and Technical School on the Basis of CC

Nowadays content-technological process in ICT companies, creating ICT products, in particular electronic learning resources includes many programming works. However, requirements for training programming personnel today do not consider enough innovative changes in the ICT industry in recent years, and the real needs of the extent of such training. These requirements are somewhat different than those put forward 40-50 years ago, when deep foundations of broad university programming education were formed and necessary amounts of training were relatively small. Modern requirements are different in qualitative terms - the content of education and quantitatively - the required amount of training is significant and over time, objectively, will significantly increase.

As for the general features of equipment and buildings of learning environment of technical vocational schools aimed for training of highly skilled workers for the ICT industry, it has material and technical features. Material and technical component of the learning environment should include: modern, mostly computer based learning tools within the equipment of subject laboratories, classrooms of general education (primarily from the natural-mathematical and technological disciplines, special training, equipment and facilities according to training specifics in certain vocational schools). All training and administrative apartments of technical vocational schools should be equipped with computer facilities (hardware and printing), and in addition with educational multimedia facilities (including multimedia boards).

To provide information and technological support of training and automation of management processes for technical vocational schools a single computer information and communication network of an institution with access to the Internet via dedicated high-speed communication lines is created and maintained. This network is administered from a single center (for this a special ICT unit is created in the institution) and includes all computer equipment,

providing different categories of authorized users with access to local automated databases, portals, sites and archives of general and limited use and support network for distance learning technologies.

Support for cloud technology infrastructure and providing users with relevant services is realized under outsourcing - a service that is required in a particular system to implement its core functions, which is offered and sold by other system external to this.

Further informatization of a technical vocational schools system on the base of cloud computing and ICT outsourcing offers realistic solutions for the deepening of informatization, improving the educational performance of ICT and use of information resources in educational practice of vocational schools located in rural areas, where the main problem is and will remain a contradiction between the objective need for continuous improvement of software and hardware power of training computer complexes and lack in qualitative and quantitative terms of personnel, able to maintain, manage and develop their ICT systems properly.

Special role in the implementation and improvement of the proposed approach should play teachers and masters of production training, managers, mentors of student-workers on basic ICT industry enterprises, who should obtain special training. The basic principles of such training should be: tight relationship of learning with training and methodological support for teachers, focus on specific educational task; modularity of learning; continuity of learning, sharing experience, formation and participation in professional associations activities (including electronic). In this process electronic distance learning systems should be actively used, based on the principles of open education [4], with the maximum possible use of CC technology and outsourcing.

There are several ways by which educational services may be outsourced on the basis of CC: SaaS - software as a service; PaaS - Platform as a service; DaaS – desktop as a service; HaaS - hardware as a service; IaaS - Infrastructure as a service; and others. Theses services are provided by the companies engaged in ICT business, based on extensive worldwide network of data centers with extra large capacity processor, communication and preserving clusters. This common infrastructure for cloud users provide a confidence that the ICT facilities and services of adaptive information communication networks would be correctly supplied and are able to meet their various needs for data processing [1, 5, 6, 7].

ICT outsourcing plays an important role in enhancing scientific and technical level of ICT-systems of vocational technical school, the efficiency of their operation and development. It is a market mechanism to incorporate the latest advances in the ICT sector and to satisfy user demand. The spectrum of ICT products is created mainly by ICT business based on the study of information resource and processing current and future needs of potential users [5, 11].

Thus the user (buyer, the customer) can get (buy) products and services proposed by the virtual supermarket of ICT according to their needs (individual or group, collective, corporate) and thus pay only for what has been bought (e -transport, e-content, e-services, virtual e-tools, a generic and subject software applications, network platforms - full range of cloud services along with services for the design and implementation of ICT systems and their fragments ordered by the users, their warranty and post warranty service, maintain, upgrade and improvement, etc.) and only for actual time of use of the purchased product. This allows the user to avoid regular updating and upgrading of powerful general system software and hardware tools of their own ICT systems, avoiding a potential surplus of ICT products that use it from time to time, fragmentary, not fully, as well as spare parts, reduction of requirements for information security of their own ICT systems, to reduce the number of their ICT services and requirements for professional competence of their employees and as a result, significantly reduce overall costs to support the operation and develop their ICT systems, to increase their social and economic return, their efficiency.

The structure of the electronic communications of hybrid service model of cloud-based learning environment is shown in Figure 1. There is an Administrator, providing access to ICT services, dealing with organization and establishment of educational services using ICT services;

there is a Tutor who is to create educational services, and the Manager, who maintains interaction between the various levels and components of the environment.
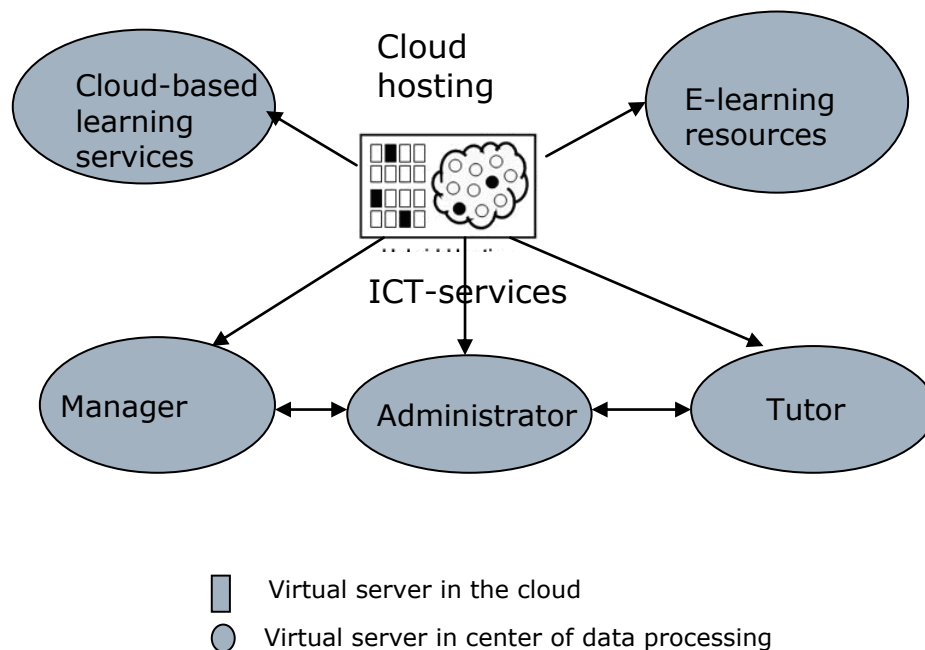

Figure 1. The hybrid service model of cloud-based learning environment of educational institution

A conceptual model for perspective training of workers for high tech industries in Ukraine

We present our vision of a conceptual model for perspective training of students for vocational education and highly skilled workers for high-tech industries.

This model presupposes CC technologies application in the process of training aiming to master technologies of the basis enterprise in vocational technical school due to access to ICT facilities and equipment on the basis of unite platform. It may solve in some way the problem of equipment modernization by means of outsourcing and supplying qualitative resources access.

There is a productive way for integration of learning processes and production, for strengthening of relations between business and education. For example, network technologies especially cloud based may be an instrument to use resources of virtual laboratories and remote access to laboratory facilities, sharing electronic resources of laboratories of various educational institutions and enterprises, pooling resources of educational institutions into unite framework [5, 12].

The conceptual origins of this model lie in the fact that on the basis of succession of professional development of workers, and deeper integration of the learning process of VET and production processes in the enterprises of the profile, it is possible to provide significant:

- deepening of orientation of the learning content and technologies to the real needs of modern industry;
- reinforcement of the faculty, which is involved in learning;
- improvement the methodical basis of the educational process;
- expansion and improvement of the characteristics of tools of the learning environment where learning process unfolds;

- release of the available training facilities and improvement of learning conditions for students and staff of vocational schools on this basis or expanding of the students contingent or diapason of training specialties;
- improvement of the quality of the regular certification of professional competence of students and workers.

Here are step by step description of the main features of the educational process and the specific structure and forms of use of some other parts of VET systems, working on the proposed model in Ukraine.

At the first stage activities are carried out: initial training and general education (adapted for the full program for vocational and technical school).

The principal feature of students training at this stage is that 100% of time students are enrolled at the vocational and technical institution. Duration of phase: 1-2 years (depending on the profession of training).

General education is based on profiling vocational and technical school. Providing in-depth study of certain subjects, the content of education involves the inclusion of educational material to address problems with the profile subject area. Courses are provided with educational literature and electronic local, network and Internet resources, and additionally the design and production documentation (on the paper and electronic media) related to educational and productive activities of the students at the basic enterprise is included.

At the second stage the next activities are performed: basic professional training and general education training (for general school program adapted for vocational and technical school). The principal feature of students education at this stage is that their basic practical skills and abilities are formed in the process of direct training and production activity at the basic enterprise. Duration of this phase: 1-2 years (depending on the profession of training).

Practical general training activities of the students are realized in vocational teaching laboratories for various subjects, practical vocational training activities - mainly on the base of the profile enterprise (professional) training. Use of new equipment, devices and equipment of the base enterprise in learning practically solves the problem of permanent and, in fact, compelling lag of vocational technical school equipment from equipment of high-tech industries due to lack of funds for regular retooling in many specialized vocational schools with a wide range of necessary training tools. Thus, in the process of industrial training in basic business enterprises the students are mainly involved in the actual real work and production program of the enterprises and can receive for their qualitative work some salary.

At the third stage deep training is carried out in the form of training at the job place. The principal feature of training of student-workers at this stage is that the theoretical part of training is mainly based on vocational institution in the form of targeted training in the process of work, and his practical professional growth takes place during the long daily production activities at the high manufacturing. Duration of this stage is not limited in time and depends on professional preparation, complexity of work performed by the worker and his individual features.

The third stage provides enhanced individually oriented theoretical training considering evolutionary upgrade of equipment, materials, general services (Internet), the achievements of scientific and technological progress, as well as specialization and profiling of specific production. Courses are provided with educational literature and electronic local, network and Internet resources, and additionally include the design and production documentation (paper and electronic media) related to the direct activities of workers at its plant.

The worker gets practical skills of complex problem solving during certain years of industrial activity in the enterprise. Though the third stage of preparation is formed and the necessary professional competence of highly skilled workers is obtained, which provide opportunities (qualifying conditions) for qualitative and in time solving of production tasks that require specific knowledge, finding innovative, unique solutions, making the previous product

model, experimentation, creative approach with a single manufacturing products with complex logic of operation and high accuracy et al. Only employees who meet these criteria can be assigned to be highly qualified and to be certified to high grade of working professionals.

According to statistical data, there is a need to bring the network of training of workers and teaching staff in accord to the real process of production. Formation of innovative ICT infrastructure of the institution could solve some of these problems, bridging the gap between the process of training and the level of demand for their product. This will form an environment that would bring together the learning resources of educational and industrial projects, covering different levels of training, including training of both students and pedagogical personnel.

The possible structure of electronic communications of the cloud-based environment for continuous education and training of skilled personnel of a region is shown on the Figure 2. There are several institutions (Vocational Schools, Technical Institution) and the Enterprise in the structure of this environment. Support of functioning and development of ICT structure is made by Learning Centre. This infrastructure is designed on the basis of outsourcing when the main ICT services are on the data centre to maintain Electronic Learning Resources (ELR) and Electronic Learning Services (ELS).

The integrated environment of education and training of skilled personnel for IT industry may be formed on the basis of several business and educational structures of a region. The main ICT facilities and services may be outsourced and supplied on the unite base. The component of the environment should be the learning center, aiming in support of training of a pedagogical personal of a school and development of ICT-based learning environment. The main purposes of a learning centre might be engagement of the regional resources into the innovative process of development. Among the aims of a Centre there are:

- practical training of vocational students and training, retraining of professional workers, who are already working at the factories of IT industry;
- in-depth study of certain subjects;
- development and introduction into the learning process of new integrated technologies, and ICT-based tools;
- formation and development of computer-based learning environment;
- providing organizational and logistical conditions for individual plans realization for training workforce for IT industry;
- conduction of training and retraining of teachers for vocational schools;
- establishment by the basic business IT enterprises centers for collective use of training and production equipment;
- implementing programs and projects that provide the concentration of resources on promising areas of the IT industry on the basis of principles of public-private partnerships, including orders of companies of domestic and foreign business firms and centers;
- development and implementation of programs to strengthen and upgrade logistics of a Center and vocational schools, involving a variety of funding sources that are not prohibited by the law;
- collaboration with industrial organizations, industrial enterprises, research organizations of different forms of ownership, including foreign ones, to perform the tasks of the Centre;
- implementation of the best international practices, including establishment of training centers of leading IT companies by of the vocational schools.
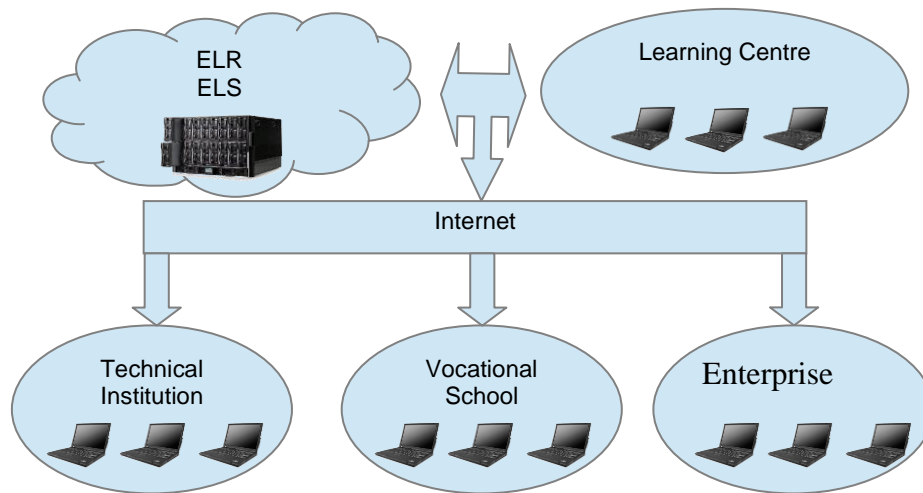
Figure 2. The model of electronic communications of a regional learning environment of training of skilled personnel for high-tech industry.

Cloud-based integrated solutions for ICT infrastructure of institution environment meet requirements of modern technological and social growth of productive forces of a region. There is a flexible and cost-effective solution to build integrated environment of continuous education and training of skilled personnel so as to broaden and make more effective use of ICT.

The holistic solution is aimed at engagement of learners, development of their performance culture, critical skills and more successful adaptation to rapidly changing environment. So the matter is to use perspective technologies so as to gain the best learning results. Such solutions are aimed at increased awareness of the benefit of adoption of learning technologies.

Analysis and evaluation of perspective ways of development of innovative learning environment

Thus, there are new approaches to development, implementation and use of electronic resources of modern educational environment of open education and training of skilled workers, based on the holistic concept of environment organization and outsourcing of the basic functions of software and ICT services. This gives the opportunity:

– to combine the processes of development and use of electronic resources to support learner competencies;
– to insure holistic approach to specialist education and training, combining both technological and social competences, development of critical skills of a learner;
– to integrate the processes of training, retraining and advanced training, and also training processes at different levels of education by the model: the schools –vocational schools – high schools – manufacturing by providing access to electronic resources of a unite learning environment;
– to solve or significantly mitigate the problems of association of electronic resources of the institution into unite framework;
– to access to the best examples of electronic resources and services to those units or institutions, where there is no strong ICT support services for e-learning;
– to provide of invariant access to learning resources within the unified educational environment, depending on the purpose of study or educational level of the student, enabling person-oriented approach to learning;

–   to make conditions for a higher level of harmonization, standardization and quality of electronic resources, which may lead to emergence of the better examples of learning resources and to more massive use them.

–   to form integrated (branch, national) databases, data collections, resources being available to various educational institutions due to cloud computing services.

Conclusion

Thus, there are new approaches to development, implementation and identifying of feasible ways of design of cloud-based solutions to construction of educational environment of continuous education and training of skilled personnel for IT industry. This improvement should be organic and adaptive processes within the overall development of the education system, the whole society and the state, meet their objectives and take into account of the restrictions. Ways of improvement and tools for development of VET, which are selected for this should be scientifically justified and balanced with the educational, scientific, technological and socio-economic factors, and therefore appropriate and promising for implementation. This approach will create a solid foundation of the formation of highly competent workers for the ICT industry - leading branch of the domestic high-tech industry.

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ІННОВАЦІЙНІ МОДЕЛІ НАВЧАННЯ І ПІДГОТОВКИ КАДРІВ ДЛЯ ІНДУСТРІЇ ВИСОКИХ ТЕХНОЛОГІЙ В УКРАЇНІ

У статті висвітлено проблеми розвитку інноваційного середовища навчання, неперервної освіти і підготовки кадрів для високотехнологічних галузей промисловості. Виявлено особливості організації інформаційно-освітнього середовища професійно-технічних навчальних закладів на основі технології хмарних обчислень і механізму аутсорсингу. Запропонована триступенева концептуальна модель навчання та підготовки кадрів для високотехнологічних галузей виробництва. Обґрунтовано моделі хмарних рішень для проектування середовища навчання для професійної освіти і підготовки висококваліфікованих робітників.

Ключові слова: інформаційно-освітнє середовище, хмарні технології, професійна освіта

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ИННОВАЦИОННЫЕ МОДЕЛИ ОБУЧЕНИЯ И ПОДГОТОВКИ КАДРОВ ДЛЯ ИНДУСТРИИ ВЫСОКИХ ТЕХНОЛОГИЙ В УКРАИНЕ

В статье рассмотрены проблемы развития инновационной среды обучения, непрерывного образования и подготовки кадров для высокотехнологичных отраслей промышленности. Выявлены особенности организации информационно-образовательной среды профессионально-технических учебных заведений на основе технологии облачных вычислений и механизма аутсорсинга. Предложенная трехступенчатая концептуальная модель обучения и подготовки кадров для высокотехнологических отраслей производства. Обоснованы модели облачных решений для проектирования среды обучения для профессионального образования и подготовки высококвалифицированных рабочих.

Ключевые слова: информационно-образовательная среда, облачные технологии, профессиональное образование