The approaches to Web-based education of computer science bachelors in higher education institutions

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Abstract. The problem of organizing of Web-based education of bachelors, and the bachelors of computer science in particular, is relevant for higher education institutions. The IT industry puts forward new requirements for future IT professionals training. This, in its turn, requires the educational process modernization: content specification, updating of forms, methods and means of training to meet the demands of socio-economic development of the society in general and bachelors of computer science in particular. The article analyzes and clarifies the notion of Web-based education of bachelors; as well as a line of approaches, such as approaches to the organization of Web-based learning for A La Carte, Station Rotation, Lab Rotation, Individual Rotation, Flipped Learning scenario; the necessity of cloud computing and virtual classroom use as a component of Web-based learning is substantiated. It is established that with the advent of a large number of cloud-based services, augmented and virtual realities, new conditions are created for the development of skills to work with innovative systems. It is noted that the implementation of the approaches to the organization of student Web-based education is carried out on international level, in such projects as Erasmus+ "Curriculum for Blended Learning" and "Blended learning courses for teacher educators between Asia and Europe". The article features the results of programming students survey on the use of Web-based technologies while learning, namely the results of a new approach to learning organization according to the formula – traditional (30%), distance (50%) and project (20%) training.

Keywords: information and communication technologies, Web-based education, approaches to Web-based education organization, cloud computing, distance learning, inverted learning, online learning.

1 Introduction

Ukraine's entry into the Bologna process stimulates the formation of new principles and approaches to the development of higher education. This, in its turn, requires the

improvement of forms, methods and tools aimed at creating a coherent system of continuing education. The requirements for the results of student's studies at universities orientate the teacher to the use of tools that are adequate to the level of development of modern technologies, processing and transmission of information, and, which is equally important, for the needs of students of the new millennium. It is becoming obvious that the tools basis of the educational process in higher education institutions should be made by means and services of ICT, augmented and virtual realities [14; 24], cloud-based and network technologies [20; 32]. The teacher should help students to initiate an internal desire to perceive the world around them with the Internet and high-tech tools which are able to create conditions for universal access to educational content as well as the latest ICT learning systems in order to make this desire a natural need.

In particular, the expected results of the adoption of the Law of Ukraine "On Education" [37] are the creation of a new generation education system that has to provide conditions for education to be received by all categories of the population of Ukraine, an effective system for ensuring comprehensive human development and promoting substantial growth of intellectual, cultural, spiritual and moral potential of the society and personality [39].

Therefore, today we are actively discussing the approaches to the Web-based education [9] of bachelors in Ukrainian universities, and, in particular, for future bachelors of computer science training, which requires substantiation of such provisions as motivational, technological, procedural support of the educational process as a holistic pedagogical system that takes into account individual interests, abilities and inclinations and the newest strategies of teaching the 21st century students.

2 Literature review and research methods

Different aspects of Web-based bachelor education in the system of higher education institutions are highlighted in the works of Olga V. Bondarenko [2], Valerii Yu. Bykov [3], Svitlana H. Lytvynova [8], Oksana M. Markova [31], Oleg M. Spirin [33], Andrii M. Striuk [34], Serhiy O. Semerikov [23], Tetiana A. Vakaliuk [11] et al. Organizational-active, general-didactic, methodological and psychological aspects are considered in their studies.

Valerii Yu. Bykov [3; 4] analyzed a model of organizational systems of open education, the use of which is possible while using Web-based technologies, examined distance learning as a component of Web-based learning. In their works, Oleg M. Spirin and Tetiana A. Vakaliuk [10; 33] consider the main possibilities of using different types of Web-based technologies and their analysis in programming training, while Svitlana H. Lytvynova states that cloud-based learning environment is a component of Web-based learning and emphasizes that synthetic web environment has to be Web-based in order to prepare bachelors of computer science as well as to enable students to engage in innovative learning tools [17; 19]. Serhiy O. Semerikov and Andrii M. Striuk proposes the organizational model of blended learning in universities, which involves the use of a learning management system and reflects the current state of development

of theory and methodology of using ICT in education [35], Volodymyr M. Kukharenko et al. research Web-based learning as a combination of traditional and online learning elements [12; 13]. Yurii V. Tryus and Inna V. Herasymenko [40] treats Web-based learning as a purposeful process of knowledge acquisition, skills acquiring, with the aim of improving the quality of education. Scientists at the Clayton Christensen Institute consider Web-based learning as a combination of new, disruptive technology [1].

Methods. This article examines such research methods as theoretical sources analysis, studying the advanced experience of foreign and domestic experts in the problem of using ICT for teaching students of technical institutions of technical higher education institutions, as well as surveys, questionnaires, modeling.

3 Research results

Rapid development of information and communication as well as Web-based changes the principles and approaches to teaching programming to bachelors of computer science in higher education institutions. There accordingly appears a need to rethink and restructure the learning process itself, update the content of the educational program, forms, means and teaching methods. It is both learning technologies and the approaches to the Web-based education organization which are changing rapidly and significantly, the education of computer science bachelors in particular.

We understand Web-based learning as a system of forms, methods and Web-based tools for the formation of professional competences of bachelors of computer science. One of most advanced and effective technologies is blended learning, which will serve as the basis for the introduction of innovative technologies, and Web-based learning in higher education institutions in particular.

The system of Web-based education has become widespread in Europe and the United States. Its rapid implementation was facilitated by the development of information and communication technologies, technical (computer) equipping of students, their high level of computer literacy as well as their ubiquitous Internet access. An important contribution to addressing the problem of Web-based education was implemented by the Online Learning Consortium, which continues dealing with the challenges associated with the Web-based education organization, improving the quality of online learning throughout the world [38, p. 99].

A significant contribution to the dissemination of the latest infrared technologies in higher education has been made through a number of international projects, including the latest learning strategies the Erasmus+ “Curriculum for Blended Learning” project, which involves the following countries: Latvia, Austria, Great Britain is devoted to innovative educational strategies. This project aims at raising national and European understanding of Web-based education, implementing the goal of integrating ICT into the process of learning, combining innovative practices with systematic, scientifically-based strategies for ICT integration [38, p. 100]. Recent studies at the Center for the Digital Education show that 90% of the teachers interviewed use creative approaches

in teaching subjects using Web-based education technologies [5, p. 4]. In Ukraine, Web-based education technology is only beginning its way.

Various definitions of it can be found in the works of scientists doing their research in the field of educational methodology. In their report on the potential effects and approaches to the Web-based education technology implementation the Sloan Consortium defined the means of hybrid or blended education as ones which integrate online with traditional face-to-face class activities in a planned, pedagogically valuable manner. Michael B. Horn and Heather Staker see Web-based education itself as an educational approach which uses online technology to not just supplement, but transform and improve the learning process [7].

Scientists at Clayton Christensen Institute describe Web-based education as a combination of the new, disruptive technology with the old technology, which represents a sustaining innovation relative to the old technology, and is actually focused on mechanical blending, i.e. combining old traditional methods of teaching with new ways arising due to the advanced technologies, which appear to be innovative in relation to old technology and, which is most important, do not offer the old technology in its full form [1].

Ukrainian experts are now at the start of the Web-based education technology implementation as well as its analyzing. Basing on experience and works of their foreign colleagues they are developing approaches to Web-based education, methodology and a system of practical recommendations which can be applied in the higher education institutions of Ukraine. Thus, Volodymyr M. Kukharenko states that disruptive approaches to bachelor's education organization give a new impetus to the development of education, they are more effective, accessible, individualized, and they will over time prevail over traditional approaches to education organizing. He also states that Web-based education as a disruptive technology can not appear on its own. Preconditions for its emergence have to be formed, as well as additional efforts, both from teachers and students' part are required during its implementation and development. [12, p. 54].

Yurii V. Tryus treats Web-based education as a purposeful process of acquiring knowledge, skills and abilities, as well as mastering the methods of cognitive activity by the subject of learning and developing his creative abilities on the basis of complex and systematic use of traditional, innovative pedagogical technologies and information and communication technologies training on the principles of mutual complementation in order to improve the quality of education [40, p. 304]. Web-based learning is an educational concept that combines traditional learning with distance education and online methods which allows students to control the time, place, trajectory, and pace of learning, Kostiantyn A. Lisetskyi notes [15, p. 2].

In particular, Valerii Yu. Bykov emphasizes that distance learning is a kind of training that is fundamentally based on the use of information and communication technologies where active participants of the learning process perform mainly individualized learning interaction both asynchronous and synchronous in time [4, p. 34].

Volodymyr M. Kukharenko et al., after analyzing works of various authors, specify that Web-based education is:

- combination of elements of traditional education and online learning;
- combination of elements of traditional education and online learning;
- combination of pedagogical theories and technologies;
- educational methodology of teaching and approach that combines traditional methods used in a classroom with computer learning activities;
- the result of integrating online courses with traditional training;
- combination of different technologies into a single integrated learning approach;
- learning program which contains a mix of auditorium and e-learning, a range of formats and media [13, p. 49-50].

Marina S. Nikitina represents approaches to Web-based education as a process that involves creating a comfortable educational information environment, a communications system that presents all the necessary training information. In this context, the information environment of a modern university is understood as a combination of traditional and innovative (electronic) forms of learning with the continuous build-up of information and communication technologies (ICTs) and digital resources, as well as constant improvement [25, p. 2].

Scientists at Clayton Christensen Institute (the USA), in their definition of blended learning as a part of Web-based learning emphasize that blended learning involves leveraging the Internet to afford each student a more personalized learning experience, including increased student control over the time, place, path, and/or pace of learning. They imply that Web-based learning has high potential. And it is not only the approaches to the organization, technology selection and ways of learning, the main idea is defined as the personalization of learning [6]. According to foreign experts personalized education involves the following major trends: deep student-centered learning experience, engaging more digital learners, building up higher-order thinking skills, realizing benefits for both teachers and students, blended and iterative approach, productive gamification etc. [1]. All students are different, they perceive information in different ways, at different rates. There is no "correct" way of mastering knowledge. It is the Web-based learning and blended learning as the basis of it that aim at helping students, who, in their turn, will be able to receive knowledge both on their own and with a teacher, as well as make a flexible individual training schedule etc.

Web-based education appears to be popular and is successfully used in various higher education institutions in Europe, the USA, Asia, Russia, Ukraine both by teachers and students. Ukrainian experts are now at the start of the Web-based education technology implementation as well as its analyzing. Basing on experience and works of their foreign colleagues they are developing approaches to Web-based education, methodology and a system of practical recommendations which can be applied in the higher education institutions of Ukraine.

Let's consider the main approaches to the organization of Web-based education for students, in particular, the bachelors of computer science in higher education institutions.

The approach to Web-based education organization with A La Carte scenario implies doing and learning a teacher's online course aimed at accompanying other kinds of learning. The A La Carte scenario gives the students an option to take an online course

with an online teacher and develops a more flexible schedule as well. A La Carte scenario courses can become a perfect option when educational institutions have no learning capacity for students with special needs. It is considered to be one of the most popular Web-based education organization approach [7]. For example, the well-known Coursera platform at Stanford University in the United States which follows this scenario offers a large number of free courses in various disciplines, including programming

The Prometheus project is a public project for open online courses in Ukraine. The purpose of the project is to provide access to online courses for all people interested in the topic. On this platform, the courses are presented not only by the teachers of the leading Ukrainian higher education institutions, but also by professors from other countries. For example, since 2016, the course "CS50: Fundamentals of Programming", [26], built as a lecture by Harvard University, has been actively used in Ukrainian higher education institutions in the blended learning format. A student or any other person may have access to video collections recorded directly in the auditorium in live communication, to summaries, tasks, additional video materials and workshops from leading experts in the field of computer science. It is worth while saying that in 2015 Yale University refused from their own introductory course of programming for freshmen in favor of using CS50, and this practice continues as long as present days.

The approach to Web-based education with Station Rotation scenario is applied for rotating in one classroom or a group of classrooms, where at least one of the stations is connected with online learning. The organization of training in this approach provides that several lessons are held in regular classes (front-end teacher-student work), and after that – students go to a computer class where they individually work on computers or tablets to consolidate knowledge.

The Lab Rotation approach to Web-based education contains a lot of points which are similar to the Station Rotation approach. The difference is that the Station Rotation Model implies students moving within the classroom allocated for them. In the Lab Rotation students move to an educational laboratory where they conduct online tutorials [7]. The Individual Rotation scenario to Web-based education organization approach enables each student to study with an individualized program mode and individual schedule. Students rotate within their individual schedule developed by the teacher [7]. The approach to Web-based education organization following the Flipped Classroom scenario assumes that students, with the help of various gadgets, listen to and review video tutorials, study additional informational sources individually (in extra-curricular time), after that they discuss new concepts and different ideas in-auditorium, where the teacher helps to apply in practice the knowledge they gained. This is the type studying process organization which encourages students to learn from each other [16, p. 235]. Individual exercises, practical tasks and independent work are also performed by students online. In other words, this approach "exchanges" classroom work and homework at home students do passive learning (i.e. reading and video lecture watching) while in the lecture room they do active learning by discussing the material more deeply.

Thus, Svitlana H. Lytvynova proves the general advantages of the Web-based education within the Flipped Learning scenario, namely: conditions for active learning

are created, a differential approach is implemented, various gadgets and latest technologies are used, the educational process is organized taking into account the needs of each individual student; conditions for team work are created; students develop leadership skills within the curriculum, the process of learning obtains personalized traits, active interaction between the teacher and the student is created, access to educational materials is enlarged; conditions for monitoring the knowledge level with the help of computer technologies are created; parents have the opportunity to participate in the child's educational process [16, p. 35].

While analyzing different aspects of the use of Web-based education of bachelors of computer science in higher education institutions of Ukraine, it is worth dwelling on the Web-based education organization for technical disciplines, which was proposed by the scientists working in the team guided by Volodymyr M. Kukharenko. This approach is considered as a methodical system, which is based both on face-to-face learning and on-line technologies (distance learning) and provides a coherent understanding of the content, internal structure, interconnection and interdependence of the elements of the process of teaching technical disciplines. [13, p.268]. Basing on the results of their own research as well as the research of foreign scientists, they offer a combination of 30% of traditional learning technologies and 70% of distance learning technologies. Classical didactic principles were used within the scope of this approach to Web-based education: consciousness, visibility, systematic, durability, accessibility, scholarly learning, as well as theory and practice close interconnection [13, p. 261]. The principles of MOOC (Massive Open Online Course) were considered as well as the principles of co-operation pedagogics and social education.

It is worth noting that while using the Web-based education, teachers use methodology which includes: forms (individual, group, collective), methods (heuristic conversation, brainstorming, discussion, situational analysis, the method of projects, training quest, etc.), tools (laboratory models, virtual simulators, electronic textbooks, etc.).

One of the approaches to the Web-based education system implementation in higher education institutions of Ukraine is the use of the Moodle [21]. The teacher uses the Moodle environment to place educational and methodological material on the discipline in various formats: text, graphics, animation, hypertext etc. Video tutorials are also placed within the Moodle in order to increase the students' motivation to study the educational material. The Moodle system gives the student access to his resources, which makes it possible to study the discipline. The student independently studies the educational material, performs the necessary training tasks, takes testing procedures in the form of exams, questionnaires, tests as well as gets involved in the forum, e-mail. This allows students to communicate with both groupmates and the teacher and ask questions without having to wait for the lecture. But, as noted by Galina A. Cherednichenko and Liudmyla Yu. Shapran, the teacher needs to clearly organize the educational process, stimulate self-control and develop different ways of productive work with students. An important factor is the formation of a stable motivation for educational and cognitive activity, which has to be maintained throughout the whole learning process [5, p. 11].

It is important to add that Web-based education methodology will work efficiently involving the following:

- interactive online learning environment;
- high-quality dynamic content (personalization of student's training, the use of adaptive technologies, coordination with national standards);
- analytical capabilities of learning management systems (LMS);
- automatization of the teacher's work;
- students' motivation [13, p. 270].

An important factor in approaches to Web-based computer science bachelor education is to ensure that programmer students have access to innovative resources which are implemented on Web-based technology basis which comes as a powerful tool for ubiquitous access to information and software systems [30, p. 104]

It is worth noting that one of the important points in Web-based training of Computer Sciences Bachelors is non-auditorium work, the proper organization of which requires the following conditions: student's motivation for independent work; availability and accessibility of educational and methodological support and reference materials; availability of computer classes; a system of regular quality control of independent studying; counseling teacher assistance [28, p. 5]

Studying approaches to the organization of Web-based training in the research of foreign and domestic scientists, as well as analyzing their long-term experience of teaching programming languages and checking the results of students in practice, the authors concluded that it is advisable to combine 30 % of innovative learning technologies and 20% of project learning technologies in Web-based learning. Project learning includes teacher – student collaborative work, teamwork and project (mini-projects development) activities of students. In the article, the authors demonstrated model of Web-based learning of Computer Science Bachelors (Fig. 1), which is presented as a set of the following components.

- independent work of the student with educational material at any place, at any time (in the classroom, at home, in another country, in transport, with the help of virtual class, by means of Moodle);
- use of Web-based environments: innovative tools (cloud computing, virtual class), skills of working with innovative systems (Web-based compilers (GitHub, AWS Cloud), programming environments, intelligence cards, automated systems of programming knowledge assessment);
- control of Computer Sciences Bachelor academic achievements. If a student is not satisfied with the level of academic achievement, he/she can complete additional tasks and increase his/her level.

Cloud services and cloud platforms, which appear as part of cloud-based learning environment, are used in the educational process to enhance professional competencies of computer science bachelors. As noted by Svitlana H. Lytvynova, the Cloud-Based Learning Environment is a specially created environment, covering all aspects of using cloud computing in organizing the training of students of all categories in different

forms and models of learning [19, p. 9]. The development of students' IC-competencies is offered on the basis of creating a synthetic Web-based educational environment to enable students to use innovative learning tools, in particular in programming [27, p. 143].

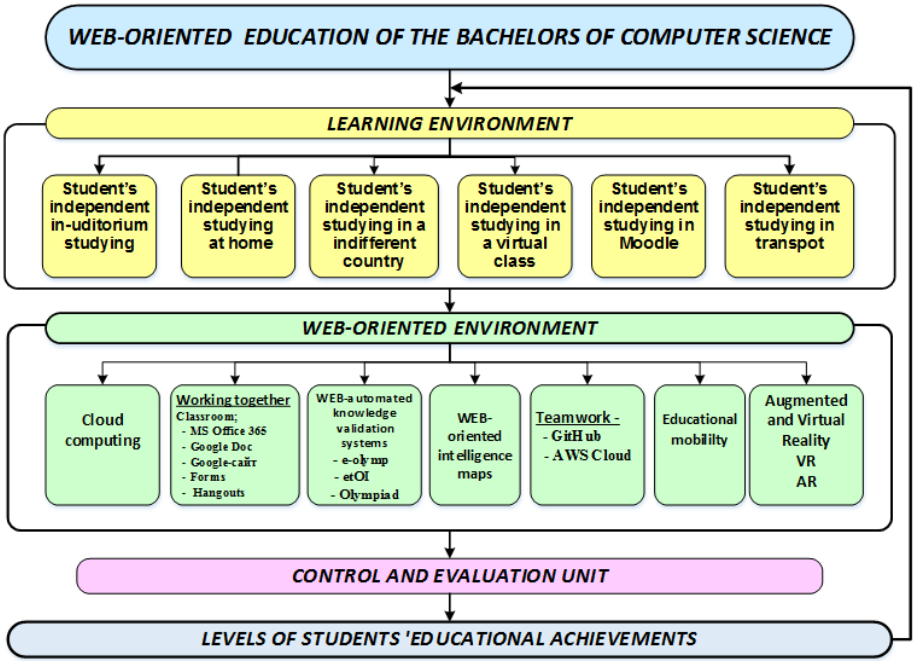

Fig. 1. The Model of Web-based learning of Computer Science Bachelors.

Such applications such as Office 365 and G Suite facilitate student-teacher collaborative work. Students' teamwork is realized through the use of Cloud-Web-based services: compilers, intelligence maps, automated knowledge testing systems for programming. Knowledge level control has to be accomplished with tests.

Important role in student activity organization is played by virtual classes (Skype, Myownconference, Etutorium, Zoom, Cisco etc.). This model is as close to real-time learning online as possible. We understand the virtual class as a special learning environment in which learning takes place in real time, integrating Internet and information-communication technologies and combining the common educational goals and objectives for the student and the teacher [18, p. 6]. A student who is absent for any reason can by virtual class means listen to the teacher's lecture in real time and participate in the discussion of the educational material.

The use of the complex approach to Web-based education of bachelors will enable students to use the learning mobility. It allows him to take an active part in the learning process while being outside the higher education institution. For example, a student is doing internship in another country, but has the opportunity to attend lectures by means of the virtual class, use the services of the Cloud-Web-based technologies for learning,

use educational contents, accomplish home assignments as well as individual tasks, communicate with the teacher etc. Academic mobility is based on an international program which implies that a student of one higher education institution can study in a different higher education institution abroad after concluding a contract.

Society's request for the development of virtual and augmented reality objects require programmers to be able to use the advanced technologies, such as the Vuforia platform, BeyondAR framework, Beyond Reality Face Nxt project, 3D tracking technologies for image recognition, tracking and geolocation AR for mobile devices, tablets and smart glasses etc. [36]

Thus, within the scope of Web-based education organization approaches analysis a survey was conducted among the students of the Technical University "Igor Sikorsky Kyiv Polytechnic Institute" within the analysis of the Web-based education of future bachelors of computer science in higher education institutions. 105 respondents took part in the survey. It was conducted to determine the programming students' attitude to the organization of blended learning in their individual preparation to programming disciplines.

The survey results showed that 59 students (56.2%) know the basic principles of Web-based education, and 46 students (43.85%) do not obtain all the necessary information about it. It is worth noting that 79 students (84.8%) would like to practice more of Web-based education, the basis of which is blended learning. In other words, students study the educational material at home independently via electronic resources, and after that to consolidate and practice the knowledge gained, in the form of a discussion (or laboratory work), under the guidance of the teacher in the auditorium. A total of 26 students (15.2%) adhere to the traditional approach to learning. The authors' point is that the latter appear to have a lack of sufficient information on the forms, methods and means of Web-based education.

Nowadays such apps as MS Office 365, Google Doc, Google Sites, Hangouts, Google Classroom are not implemented at a sufficiently high level at the departments of the university. Therefore, out of 100 respondents, 43 students (43%) use Excel Online, 42 students (42%) – Word Online, 34 students (34%) – Google site, 32 students (32%) – PowerPoint Online, 28 students (28%) – Forms Online, 16 students (16%) – Google Classroom, 67 students (67%) Telegram, etc. (Fig. 2).

The IT industry activity sphere increases each year, new programming languages appear, new computer science methodologies and technologies are developed, and project management is improved. This, in its turn, increases the amount of educational information for a programming student to master. There is a large number of techniques for processing information today. The use of Web-based intelligence cards appears to be the most important. It is the application of intelligence card method itself that becomes a new tool that provides structuring, systematization, specification and effectively influences student's memorizing information for further use [31, p. 132]. This method not only visualizes and organizes large volumes of educational information, but becomes a motivator for further studying as well.

According to respondents' survey results, the use of Web-based and cloud-based intelligence cards in the university departments is low: 11.8% of students apply them in educational activities, and 88.8% do not pay sufficient attention to these services. A

similar survey among programming students was conducted in 2018, its results showed that "in the educational process of programming languages teaching in higher education institutions such web-based technologies as compilers, automated programming verification systems, intelligent maps are not applied in the full capacity" [29, p. 84].

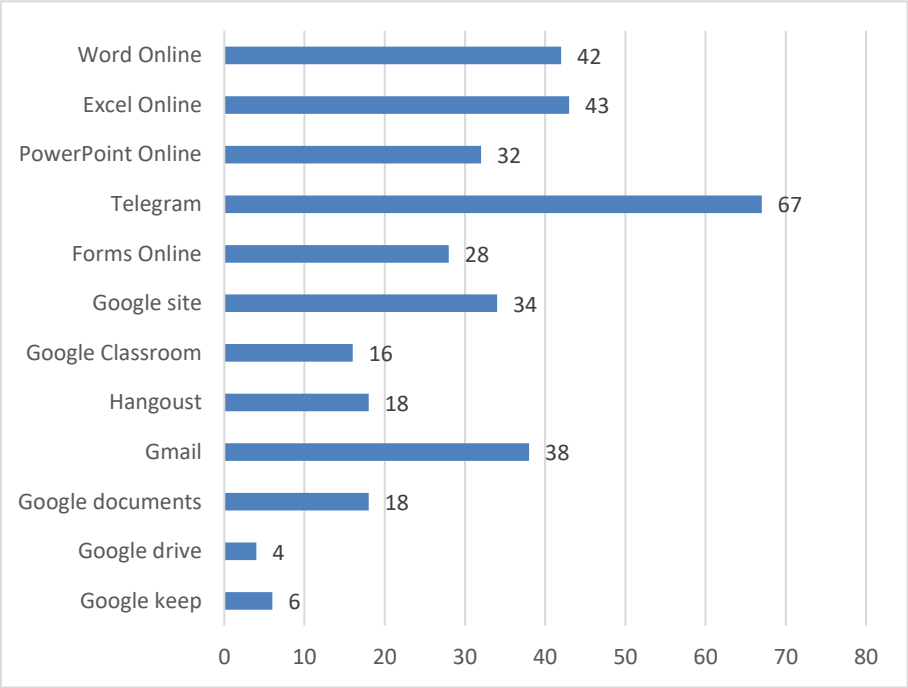

Fig. 2. Using of Applications in the course of Web-based Computer Science Bachelor's training.

After comparing the results of 2018 and 2019 surveys, the authors conclude that the use of Web-based intelligence cards within the independent study of teaching materials in the discipline of programming grew by only 1.8%, which actually means it didn't change. The polling rate of respondents in the 2019 survey makes 11.8% [29, p. 84] compared with 10% of the 2018 poll.

Respondents' survey results showed that future bachelors of computer science should pay more attention to the use of Web-based and cloud-based automated testing systems for programming tasks in preparation for practical lessons in the course of programming. The statistics on the use of these systems is presented in Fig. 3 and it demonstrates that out of 112 respondents, 78% do not use any of the systems presented in the programming tutorials, 33% – use E-olymp, etc.

One of the peculiarities in the learning process of future bachelors of computer science is the point of studying several programming languages. Therefore, it is important for comprehensive development in programming that students-programmers get acquainted with different types of compilers, such as Web-targeting and cloud

compilers, starting from their first year of studying. This will enable them to program from any location, at any time and thereby accelerate the process of programming learning.

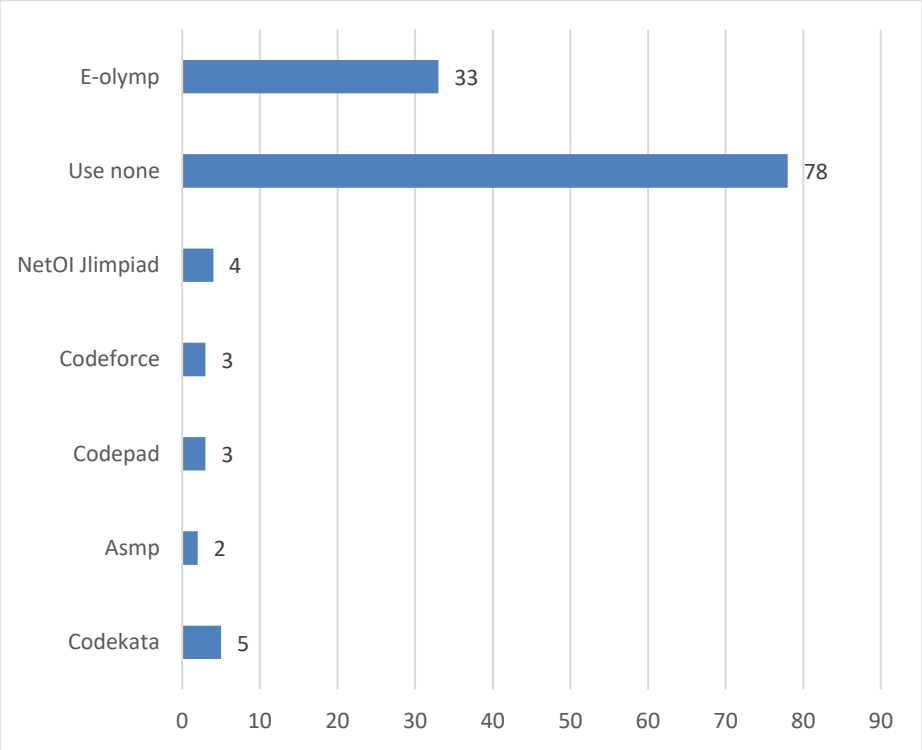

Fig. 3. Using of Web-based automated systems for testing programming tasks in the course of Web-based Computer Science Bachelor's training.

Figure 4 shows the rate on the use of Web-based compilers within the students' independent work on practical programming tasks, namely: Codepad.org (3%), Ideone.com (4.1%), Cppshell (9%), jsFiddle (2%), WandBox (20%), Tutorials Point (4%), do not use any Web-based compiler (89%).

Use of Web-based automated systems for testing programming tasks in the course of Web-based Computer Science Bachelor's training.

Analyzing the results of NTUU "Kiev Polytechnic Institute Igor Sikorsky" student-programmers survey the authors came to the conclusion that such innovative technologies as Web-based and cloud-based applications are highly required for students to master while learning. Therefore, it is advisable to include practical lessons, laboratory work, project development, innovative software in the educational curriculum.

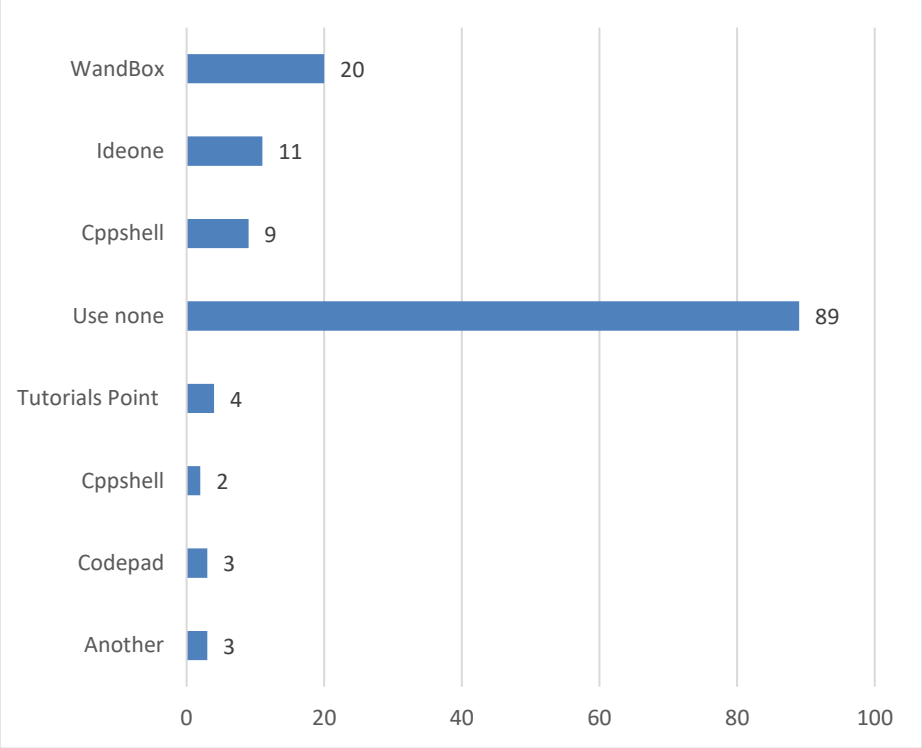

Fig. 4. Using Web-based Compilers in the course of Web-based Computer Science Bachelor's training.

4 Conclusions

After analyzing the experience of applying Web-based education approaches in different countries, we conclude that both in Ukrainian universities and abroad – various approaches to bachelor educating (and computer science bachelors in particular) in higher education institutions are used quite actively. The difference lies in national traditions as well as the approaches to the content of education itself.

It is noted that Web-based education organization implementation is applied internationally, in such well-known platforms as Coursera (USA), Prometheus (Ukraine), international projects like Erasmus +, "Curriculum for Blended Learning" and "Blended learning courses for teacher educators between Asia and Europe". However, it is not applied in the system of higher education institutions widely.

The article considers approaches to Web-based education organization, in particular, blended learning of future bachelors of computer science, such as flipped learning approaches, A La Carte, individual rotation, which are popular among higher education institutions in Europe, the USA, Asia and Russia. Meanwhile Moodle and flipped learning have been widely used in Ukraine.

While studying the Web-based learning organization approaches in the research of foreign and domestic scientists, as well as analyzing the results of the student-programmers survey, the authors emphasize that it is advisable to use the Web-based programming teaching system for educating future bachelors of computer science, which offers 20% of project training, 30% of traditional and 50% of distance learning.

Some of the disadvantages of blended learning include the fact that teachers need to devote a lot of time for preparing interesting and understandable teaching materials (video lectures, methodological guidelines for carrying out practical work, etc.). It is also very important for the strategy of Web-based learning to be supported by the administration of higher education institutions.

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