Using Massive Open Online Courses in Teaching the Subject "Computer Networks" to the Future IT Specialists

Tetiana A. Vakaliuk[1[0000-0001-6825-4697]], Andrii A. Yefimenko[1[0000-0003-2128-4797]], Viktoriia V. Bolotina[1[0000-0002-5122-8879]], Yelyzaveta M. Bailiuk[1[0000-0002-4961-7816]], Oleksandra A. Pokotylo[1[0000-0002-1587-235X]], and Svitlana Didkivska[2[0000-0002-4004-6631]]

[1] Zhytomyr Polytechnic State University, 103, Chudnivska Str., Zhytomyr, 10005, Ukraine
[2] Zhytomyr Secondary School I-III degrees № 14, 7, Kybalchycha Str., Zhytomyr, 10009, Ukraine
tetianavakaliuk@gmail.com, yefimenko.andrii@gmail.com, viktoriia.polish@gmail.com, liza.bailiuk@gmail.com, a.a.polish4uk@gmail.com, zzzdafzzz@gmail.com

Abstract. The article presents the experience of using massive open online courses in the training of the discipline "Computer Networks" of future IT specialists. The content of the study of the discipline "Computer Networks" in different institutions of higher education in Ukraine is analyzed. It is noted that in the study of this discipline at the Zhytomyr Polytechnic State University to work independently through the platform of massive open online courses Cisco Networking Academy material of the integrated training course CCNA Routing and Switching. The description of the possibilities of using mass open online courses in the training of discipline "Computer Networks" of future IT specialists. The expediency of the use of mass open online courses in teaching the discipline of "Computer Networks" of future IT specialists through the pedagogical experiment, the results of which proved the feasibility of introducing these courses in the educational process of higher education.

Keywords: massive open online courses, computer networks, IT professionals.

1 Introduction

1.1 Formulation of the Problem.

In the process of professional training of students of all specialties 121, 122, 123, 124, 125, 126 industry 12 "Information Technology" binding study is discipline "Computer Networks". Analysis of the curricula of higher education institutions Ukraine (Zhytomyr Polytechnic State University, National University of Life and Environmental Sciences of Ukraine, Ternopil Ivan Puluj National Technical University, National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”, Taras

Shevchenko National University of Kyiv) showed that the study of subjects given 120 to 270 hours.

It determines the need to use platforms of massive open online courses (MOOC) in higher education institutions (HEI). Platforms MOOC usually contains traditional materials for learning (video lectures, text materials for self-study and related control tasks), but sometimes contain various additional features. For example, the ability to create a forum (chat) for registered users, where students can communicate and receive a variety of answers to their questions, not only from teachers but also from other MOOC users [1; 2].

1.2 Analysis of Recent Research and Publications.

Many scientists are exploring the problem of training IT professionals. In particular, T.V. Bodnenko, O.G. Glazunova, M.I. Zhaldak, V.V. Eremeev, O.V. Kharchenko, N.V. Morse, V.V. Osadchyi, O.M. Spirin, S.O. Semerikov, T.V. Voloshyna, and others.

In particular, V. Osadchyi conducted an analysis of the content and organization of training of specialists in software engineering at US universities [3], T.V. Bodnenko and O.V. Kharchenko investigated the problem of using cloud technologies in the process of training computer engineer [4], T.V. Voloshina developed a technique for using a hybrid cloud-oriented learning environment for the formation of self-educational competence of future IT specialists [5], O.G. Glazunova and O.V, Yakobchuk investigated the issues of architecture design cloud-based information and educational environment for training future professionals [6].

O.G. Glazunova also developed a methodological system for the application of an e-learning system for future specialists in information technologies in universities of agricultural profile [7]. L.F. Panchenko and N.A. Lavrynenko highlighted the problems of using multiagent systems in the training of future IT specialists [8], A.M. Striuk and M.I.Striuk consider methodical aspects of the use of cloud-oriented tools in the training of information specialists technologies [9].

Other researchers (N. Avshenyuk [10], N. Berezan [10], N. Bidiuk [10], M. Childs [11], G. Conole [11], M. Haenlein [12], A. Inamorato dos Santos [11], A.M.Kaplan [12], M. Leshchenko [10], B. Nkuyubwatsi [11], Y. Punie [11], A. Tannhäuser [11], G. Witthaus [11]) are exploring various aspects of the use of massive open online courses in higher education institutions

However, the use of platforms open massive online courses during their training today needs further examination.

2 Results

The purpose of the Computer Networking course is to give students the knowledge of:

- Principles and standards for the construction and operation of computer networks;
- Local and global computer network technologies;
- Information exchange protocols used on computer networks;

and develop students' skills:

- Analysis of hardware and software solutions of computer networks;
- Practical skills in designing, implementing, operating computer networks;
- installing, debugging and administering network software.

The tasks of studying the discipline "Computer Networks" are: studying the general principles and standards of building computer networks, technologies of local computer networks, TCP / IP stack protocols, routing in IP networks, technologies of global networks and access networks, network operating systems and network software.

Here is an indicative subject of study of this discipline:

Topic 1. Introduction. Basic definitions and standards for computer networks.

Topic 2. Topologies, data channels, data networks on computer networks.

Topic 3. Computer Networking Models. OSI reference model.

Topic 4. Basic LAN technologies.

Topic 5. Modern high-speed local area network technologies.

Topic 6. Building computer networks based on hubs, bridges, and switches.

Topic 7. TCP / IP stack. Basic protocols.

Topic 8. Routing in IP Networks.

Topic 9. Technologies for support, global and access networks.

When studying this discipline at the Zhytomyr Polytechnic State University, students are taught to work on the CCNA Routing and Switching Integrated Training Course through Cisco Networking Academy Massive Open Online Courses [13], which consisting of separate smaller courses, namely: CCNA Routing and Switching: Introduction to Networks, CCNA Routing and Switching: Essentials, CCNA Routing and Switching: Scaling Networks, CCNA Routing, and Switching: Connecting Networks. The CCNA Routing and Switching course provides online training, test work, and test intermediate assessments.

In the course of studying CCNA Routing and Switching courses, Cisco Academy offers the following study material:

CCNA R&S: Introduction to Networks. The purpose of this course is to be acquainted with the basic concepts and technologies of networks. This knowledge can be immediately applied to the configuration of switches and routers. This course details the principles, models, technologies, and protocols of networking, including how Ethernet devices work the basic TCP / IP stack protocols.

CCNA R&S: Essentials. This course describes the architecture, components, and features of routers and switches on small networks. The course will provide you with the skills to set up and troubleshoot networking equipment, as well as common problems with RIPv1, RIPng, OSPF dynamic routing, VLANs, and VLAN routing on IPv4 and IPv6 networks. This course also examines the work of DHCP and NAT technology.

CCNA R&S: Scaling Networks. This course focuses on the architecture, components, and functions of networking equipment on larger and more complex networks. The course aims to gain practical skills in configuring and troubleshooting routers and switches with advanced features, namely to solve common problems with OSPF, EIGRP routing protocols in IPv4 and IPv6 networks. Besides, the course develops knowledge and skills to implement wireless LAN in small and medium-sized net-

works.

CCNA R&S: Connecting Networks. This course discusses WAN and network services required by converged applications in complex networks. The choice of network equipment and WAN technologies to meet network requirements is discussed. This course also allows you to develop the skills needed to deploy VPN into complex networks.

Initially, courses offered by the Cisco Academy are created in English and only then translated into other languages. As a rule, a community of trainers does translation and localization of the course. Localized (translated) courses are due one month to one year after a new course or a new version of the course is available. Some courses, often professional-level courses, do not translate at all. The Cisco Ukrainian Academy of Instructors community is working intensively to translate the latest English language courses into Ukrainian. At the end of 2019, there are four such courses. At least four more courses related to network technology and cybersecurity are planned to be translated in 2020.

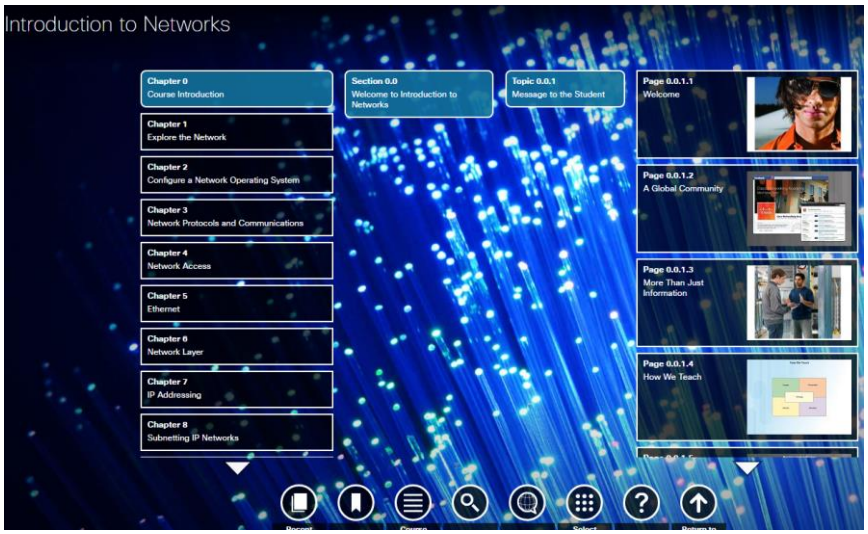

Fig. 1. Example system interface (course CCNA Routing and Switching: Introduction to Networks)

Let us look at some of the technical aspects of the Cisco Academy training courses. Cisco Academy is hosted on a cloud-based Netacad (Netacad.com) platform (an Amazon AWS cloud provider). The following courses are available at the Academy: self-led, self-led, and instructor-led. However, three levels of complexity are most common: beginner - for beginners (often open), Intermediate and Advanced - professional levels (usually closed or paid). Training facilities are available for educational institutions: 1) Cisco Academy - Student Learning, 2) Cisco ITC (Cisco Instructor Training Center), 3) Cisco ASC (Cisco Academy Support Center) - Cisco Academic Support Center.

Note that the Zhytomyr Polytechnic State University and Cisco have an agreement

on cooperation in student learning (cooperation began since 2000), and in September 2019, the University of Cisco Instructor Training Center and the Cisco Academy Support Center opened at the University. It is worth noting that not only universities, but also schools, colleges, and other institutions around the world collaborate with Cisco Academies.

So, for the self-study course "Computer network" Students are encouraged to go through four courses Academy Cisco. Let's take a look at one of these to get a closer look at the discipline of Cisco Academy.

Note that the Cisco Academy platform is adaptive across devices and systems, so users can access the learning environment through their account from any device (smartphone, tablet, laptop or PC). However, some of the specialized training programs or multimedia tools you need (for example, Packet Tracer network simulators, some tests, and some exams) are complex and resource-intensive, so you should use a laptop or PC to work with them.

The NetAcad environment is responsible for the interaction of instructor-trainers and students (students). The course materials include theoretical material (lectures in conjunction with graphic materials, video materials, game training cards for mastering the basic concepts of the topic) and performance materials (laboratory work, Packet Tracer work, tests and exams for each topic, as well as the final exam).

When educating future IT professionals, combining traditional approaches to blended learning with Cisco Academy allows you to apply a personalized approach to the learning process, increase student interest and motivation, and build student-teacher interaction.

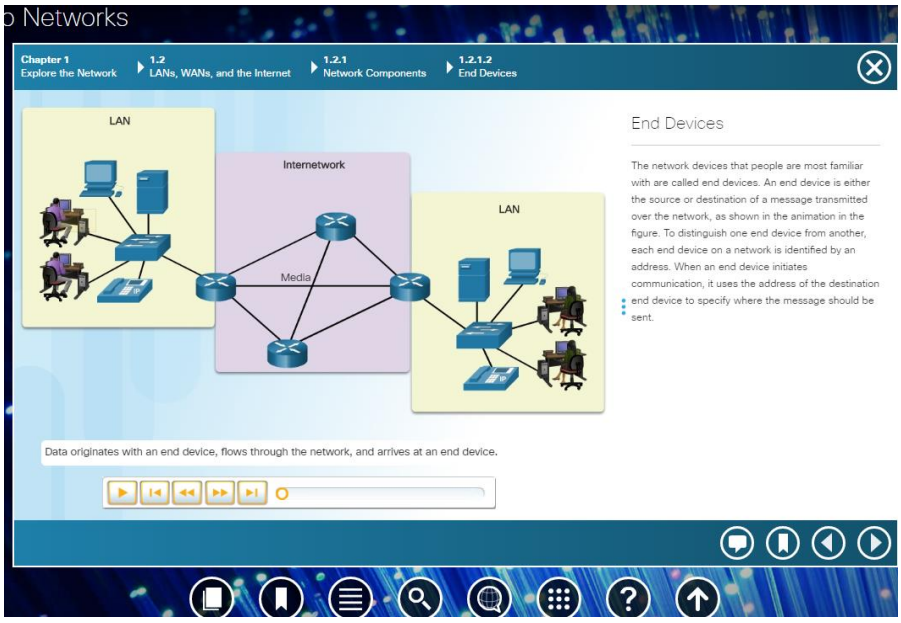

Fig. 2. Theoretical material

To begin with, students are encouraged to familiarize themselves with the theoreti-

cal background of the chosen topic. The theoretical material is accompanied by graphic and video materials (see Fig. 2–3). Note that the video material can also be viewed in text format (see Fig. 3).

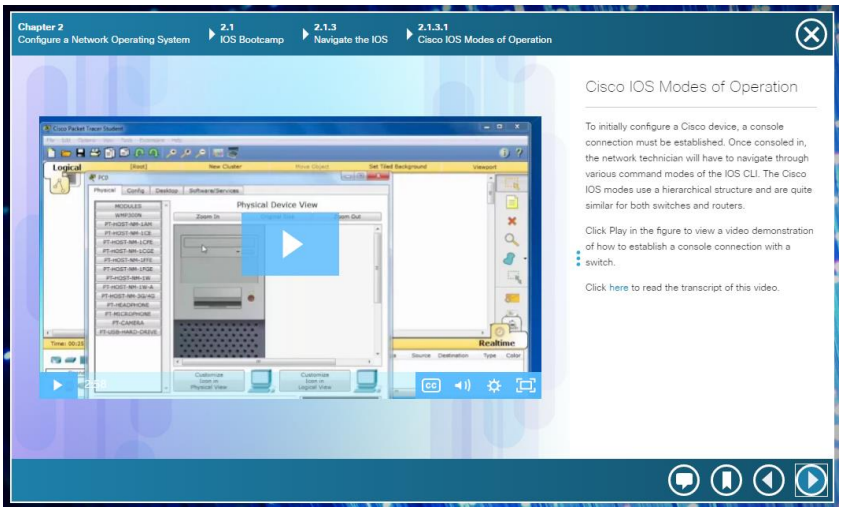

Fig. 3. Theoretical material (in the form of video material).

It should be noted that all the material is structured, and according to each topic, there are different types of submitting material and testing the knowledge (see Fig. 4).

With the help of the course pointer you can view the general list of materials, the list of works in Packet Tracer, the list of laboratory works, and the list of video materials (see Fig. 4).

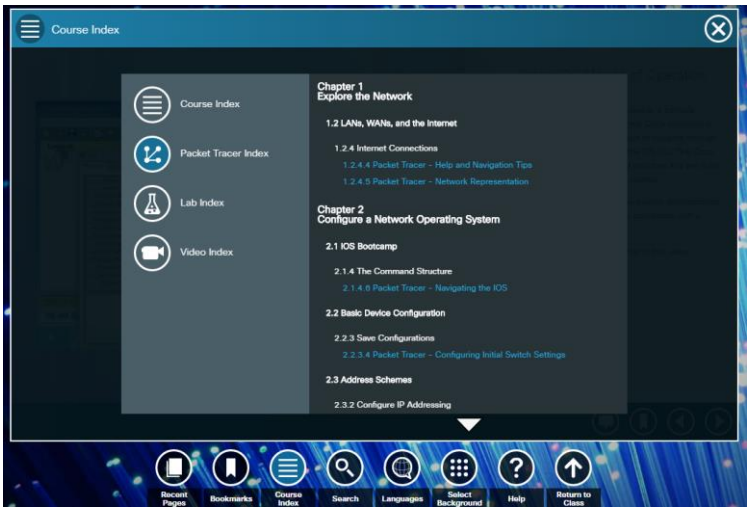

Fig. 4. Types of work

To perform the test and exam work, to view your grades, you must select the menu

"Back to class" (see Fig. 5).

Fig. 5. Course navigation

On the home page (home) of the course, you can choose course start (includes passing of theoretical material, video lectures, laboratory work, as well as work in Packet Tracer), tasks (includes all intermediate and final exams), tests (list of tests course work), assessments, etc. (see Fig. 6).

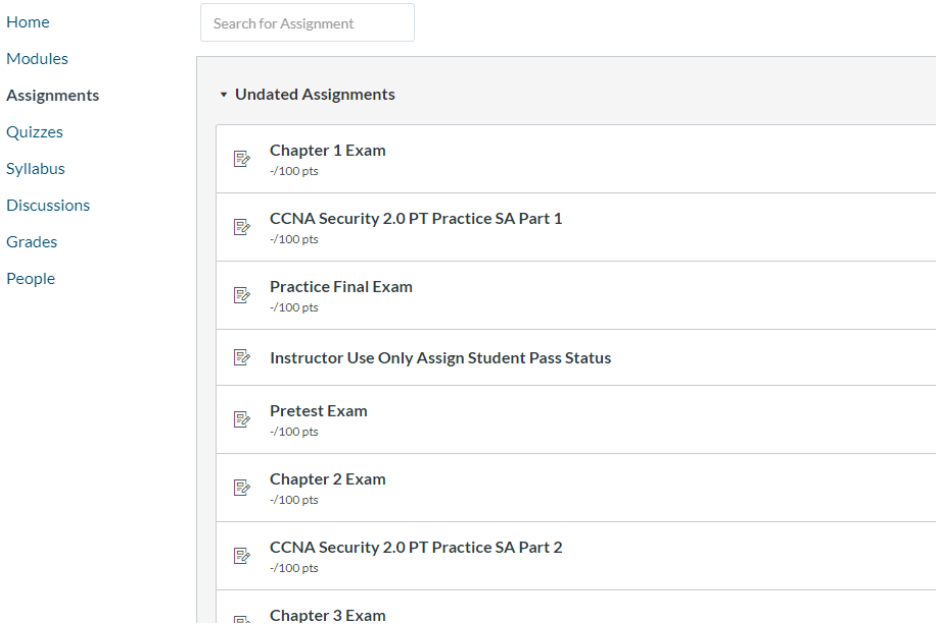

Fig. 6. Course page

Each test work is instructed to complete the test, indicating the time, the maximum score, the number of questions, limiting time and trying (see Fig. 7).

All tests are performed as tests. In this case, the assessment for the control work in the evaluation log is not submitted. This is just your preparation for the exam work on the topic as a whole.

After completing the test work, the system will provide the user with a complete description of the work completed (evaluation, correct answers, etc.).

You can review all the attempts and retake the test.

As a result, the journal estimates will be recorded only assessment of all examinations. This is a bit inconvenient for students as they are accustomed to traditional training when grades for tests are taken into account and only one exam is taken at the

end of the course.

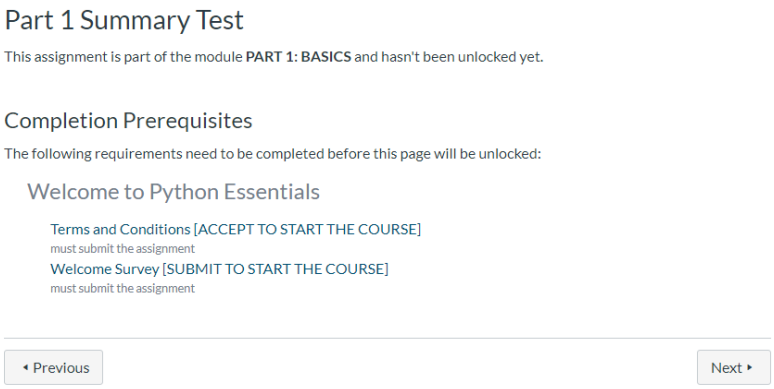

Fig. 7. Instructions for control work.

Therefore, we consider it necessary, at the beginning of the course, to warn students about the specifics of this platform and to explain that the test work is only a training exercise, and the grades that are taken into account are the grades for all exams.

The advantage of this approach to learning is the acquisition of the subject through practical experience, using different types of practical work. To do this, students have the opportunity to see examples of solutions (the used text and multimedia); try to apply this knowledge in practice (using syntax checking tools); execute part of the example (using Packet Tracer or real equipment); and, finally, finding a solution to the problem (applying all the knowledge gained and using the tools available).

Note that Packet Tracer - a tool for visual simulation, developed by Cisco Systems, which allows users to create network topology and simulate modern computer networks. This software includes a wide range of physical and logical modeling systems (see Fig. 8).

The variant exercises with the use of this software include modeling networks, games, exercises, and more complex tasks, enabling end variants to gain practical experience working with computer networks.

Using Packet Tracer, students can create their experiments on computer networks. This is an opportunity to explore the particular job designed network protocol TCP / IP.

With this program have the opportunity to compete with each other participants and the whole team from performing certain types of tasks.

Using complex material and exercises proposed Academy Cisco, facilitates self-study materials to students, increases their interest in using vivid visualization of the entire material and game simulations in software tools Packet Tracer.

The use of these courses provides 100% coverage of topics prescribed curriculum study subjects.

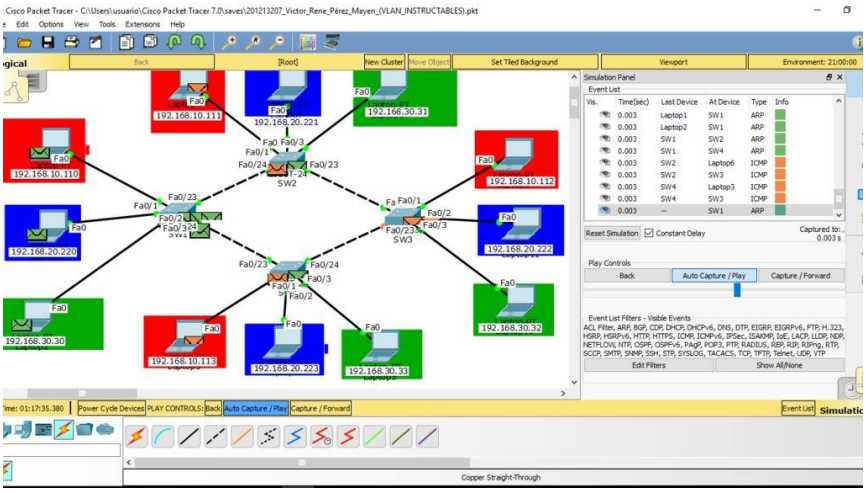

Fig. 8. Packet Tracer

Note that the Academy offers instructors a statistic (see. Fig. 9-11), where you can see the dynamics study courses on various parameters.

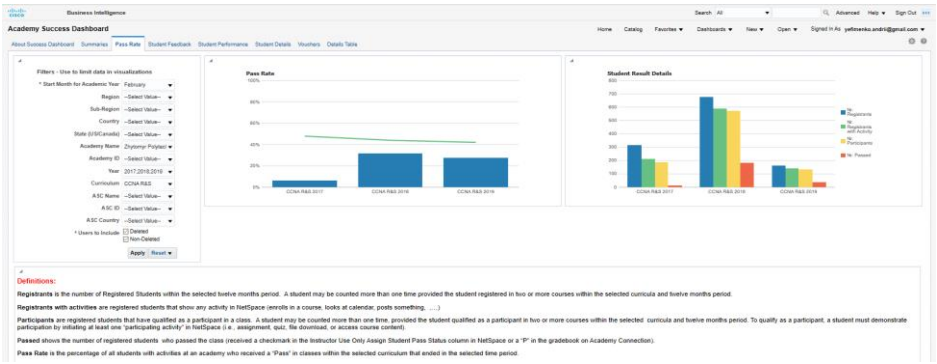

Fig. 9. Statistical Images of Course Studies at Cisco Academy

Fig. 10. Statistical Images of Course Studies at Cisco Academy

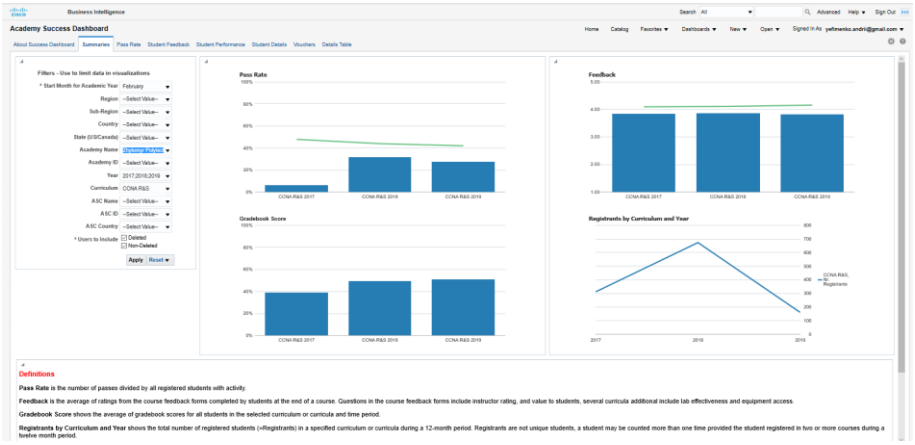

Fig. 11. Statistical Images of Course Studies at Cisco Academy

3 Discussion

To test the effectiveness of the implementation of courses Cisco Academy in the educational process of higher education, the pedagogical experiment was conducted at the Zhytomyr Polytechnic State University.

To do this, we measured the level of academic achievement of students by examining the discipline of "Computer Networks" at the beginning and end of the pedagogical experiment.

For this purpose, students were divided into experimental and control groups (EG and CG, respectively). At the same time, computer networking courses at EG were conducted using Cisco Academy courses and at CG at the usual methodology.

Table 1 and Fig. 12 show comparative statistics before and after the EG and CG experiments, respectively.

Table 1. Comparative distribution of CG and EG students by level of academic achievement at the beginning and end of a pedagogical experiment

Level of academic achievement	Before		After	
	CG	EG	CG	EG
Initial (1-59)	7	8	6	5
Average (60-73)	22	24	18	6
Sufficient (74-89)	18	16	21	30
High (90-100)	6	5	8	12
Total	53	53	53	53

At the beginning of the pedagogical experiment, Pearson's χ^2 test was used to check the statistical equivalence of EG and CG, which revealed that the samples had no

statistically significant differences (since χ^2_{emp}=0,36, χ^2_{emp} <$\chi^2_{0,05}$). Therefore, it is possible to say about equal conditions in EG and KG, as well as about the equal composition of their participants.

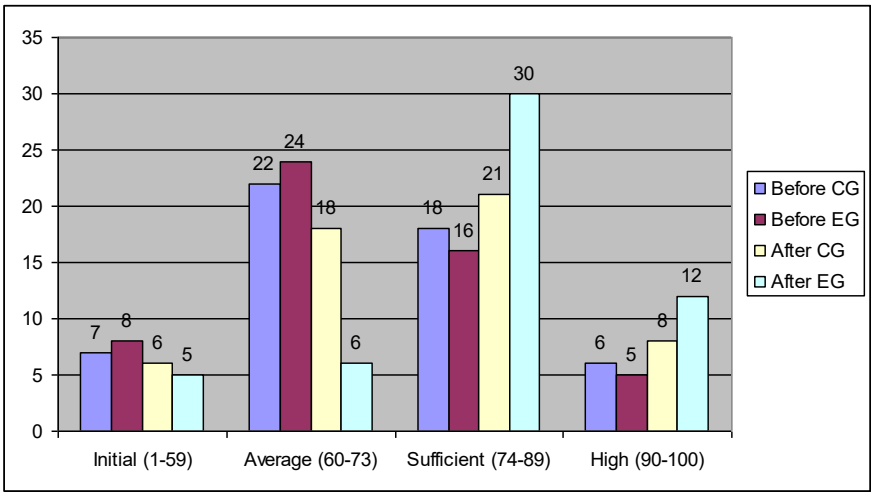

Fig. 12. Comparative distribution of students in CG and EG by the level of educational achievement at the beginning and end of the pedagogical experiment

As the statistics show the positive dynamics of a sufficient and high level of educational achievement in the experimental group, at the end of the pedagogical experiment, the Pearson χ^2 criterion was similarly applied. As a result, it was found that the sample had statistically significant differences at this stage, since χ^2_{emp} =8,48, χ^2_{emp}>$\chi^2_{0,01}$.

This means that an experimental methodological training system for "Computer Networks" using MOOC is more pedagogically appropriate than the traditional one.

4 Conclusions

Finally, it should be emphasized that at the Zhytomyr Polytechnic State University Cisco Academy courses are introduced not only in the discipline of "Computer Networks", but also in the study of such disciplines as: "Fundamentals of Cyber Security", "Programming in Python", "C / C ++ programming" (within practice) and more.

In the future, it is planned to expand the network of Cisco Academy courses to schools, colleges, lyceums and other educational institutions of Ukraine.

References

1. Vakaliuk, T.A.: Review of existing mass open online courses suitable for use in the preparation of bachelors of computer science (in Ukrainian). In: Information technologies

in education and science: Collection of scientific works. **10.** Pp. 46-50. (2018).
2. Vakaliuk, T.A.: Selection of mass open online courses for use in the preparation of bachelors of computer science (in Ukrainian). In: Scientific Bulletin of the Melitopol State Pedagogical University. Series: Pedagogy. **3 (20)**. Pp. 128-133. (2018).
3. Osadchyi, V.V.: Analysis of the content and organization of training in software engineering at US universities. (in Ukrainian). In: Pedagogical discourse. **20.** pp. 107-114. (2016).
4. Bodnenko, T.V., Kharchenko, O.V.: The use of cloud technologies in the preparation of computer systems engineer (in Ukrainian). In: Cloud technologies in education: materials of the All-Ukrainian Scientific and Methodological Internet Seminar, p. 149 (2012).
5. Voloshina, T.V.: The use of hybrid cloud-oriented learning environment for the formation of self-educational competence of future information technology specialists: Ph.D. ped. Sciences: 13.00.10, 292 p. (2018). (in Ukrainian)
6. Glazunova, O.G., Yakobchuk, O.V.: Designing the architecture of a cloud-oriented information and educational environment for the preparation of future specialists in information technologies (in Ukrainian). In: Information Technologies and Learning Tools, **6 (44).** pp. 141-156. (2014) https://journal.iitta.gov.ua/index.php/itlt/article/view/1133/875.
7. Glazunova, O.G.: Theoretical and methodological principles of design and application of e-learning system of future specialists in information technologies in universities of agrarian profile: author. diss. ... Dr. Ped. Sciences: 13.00.10, 40 p. (2015). (in Ukrainian).
8. Panchenko, L.F., Lavrynenko, N.A.: Problems of application of multiagent systems in the preparation of future specialists in information technologies. (in Ukrainian). In: Scientific notes of Berdyansk State Pedagogical University. Pedagogical Sciences: Coll. Sciences. **3.** pp. 224-230. (2015).
9. Striuk, A.M., Striuk, M.I.: Methodical aspects of the use of cloud-oriented tools in the training of information technology professionals. (in Ukrainian). In: Cloud technologies in education: materials of the All-Ukrainian Scientific and Methodological Internet Seminar. pp. 145-146. (2012).
10. Avshenyuk, N., Berezan, N., Bidiuk, N., Leshchenko, M.: Foreign experience and Ukrainian realities of the use of mass open online courses in the international educational space (in Ukrainian). In: Information Technologies and Learning Tools, **6 (68)**, pp. 262-272 (2018). https://journal.iitta.gov.ua/index.php/itlt/article/view/2407.
11. Witthaus, G., Inamorato dos Santos. A., Childs, M., Tannhäuser, A., Conole, G., Nkuyubwatsi, B., Punie, Y. Validation of Non-formal MOOC-based Learning: An Analysis of Assessment and Recognition Practices in Europe (OpenCred). EUR 27660 EN; doi:10.2791/809371 (2016).
12. Kaplan Andreas M., Haenlein Michael: Higher education and the digital revolution. In: About MOOCs, SPOCs, social media, and the Cookie Monster, Business Horizons, **59**. (2016).
13. Academy Cisco. https://www.cisco.com/c/uk_ua/index.html.
14. Pinchuk O., Burov O., Lytvynova S. Learning as a Systemic Activity. In: Karwowski W., Ahram T., Nazir S. (eds) Advances in Human Factors in Training, Education, and Learning Sciences. AHFE 2019. Advances in Intelligent Systems and Computing.. **963.** Pp. 335-342.(2019) https://doi.org/10.1007/978-3-030-20135-7_33.
15. Proskura S., Lytvynova S. Organization of Independent Studying of Future Bachelors in Computer Science within Higher Education Institutions of Ukraine. Proceedings of the 14th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer. **2104.** P. 348-358. (2018) URL:http://ceur-ws.org/Vol-2104/paper_160.pdf