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Evaluation of the efficiency of teaching future informatics teachers in computer networks based on modeling of networks.

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Abstract

When organizing training in computer networks on real equipment, educational institutions face organizational, technical and material difficulties. Using network modeling, the above difficulties can be avoided in teaching future informatics teachers about computer networks. The aim of the research was to prove the effectiveness of teaching future informatics teachers to computer networks based on network modeling. The method of theoretical analysis is carried out in order to comprehensively study the state of the problem under consideration. A pedagogical experiment has been conducted for evaluating the efficiency of teaching computer networks based on modeling. The study has been organized in experimental and control groups. Mathematical statistics were used for the analysis. In the course of the study, it was found that the development and implementation of the proposed teaching methodology provides an opportunity for full and high-quality training of future informatics teachers in the field of computer networks, which allows them to solve professional problems in the design, maintenance, configuration and administration of computer networks.

Keywords: programming environment; informatics teacher; network technologies; teaching methods; informatization.

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1. Introduction

Changes in society and technology pose new challenges to the education system. An important component in the organization of the educational process in the context of the informatization of education is information and educational systems that use network technologies and are an integral part of the information and educational environment of an educational institution. One of the conditions for the normal functioning of the educational information environment for educational institutions is the availability of qualified specialists who ensure the creation, development, and professional service of information educational environments (Nagyová, 2018). The maintenance of information educational environments is understood as the administration, monitoring, ensuring information security of the educational environment of a particular institution at the basic level of network technologies (Tagaeva et al.,2018; Yakymchuk & Kazachenok, 2018).

In schools, this task (software and technical support of the information and educational environment), as a rule, is entrusted to the informatics teacher, who must have appropriate training in this area, i.e. have the required level of professional competence.

It should be noted that the problems of training IT specialists have been studied by (Yakymchuk & Kazachenok, (2018), Olifer & Olifer, (2016), Fakhar, (2019), Calle, Tovar, Castaño-Pino & Cuéllar, (2018) and other issues of training informatics teacher in this direction are reflected in the works of Damekova, (2008), Nikitin, Melnikova, & Gorokhova (2014), Sergeev (2016), Lyash (2008), Lyaginov (2011), Shestopalova (2014), Mogilev et al. (2004).

Let's consider one more position, which is more specific and, at the same time, determining in the framework of our study when choosing a means of teaching future informatics teachers to computer networks (Imputato & Avallone, 2019). The information security policy implemented in the computer network of educational institutions, as a rule, grants students the minimum necessary rights to work with equipment and software. Therefore, the future informatics teacher has practically no opportunity to learn how to professionally solve problems related to the use of equipment, network technologies that require significant access rights (installing software, setting up a network operating system, administering a computer network, ensuring the security of its functioning, etc.).

Thus, future informatics teachers have a need to acquire professional knowledge and skills in the field of network technologies, and the teacher has a duty to provide them with the necessary training.

But here a serious contradiction arises, associated with the stable functioning of the computer network of an educational institution in the context of a real educational process. The information security policy implemented in them, as a rule, grants students (and teachers) the minimum necessary rights to work with hardware and software. Therefore, the future informatics teacher practically does not have the opportunity to learn how to professionally solve problems that require significant access rights and are associated with the real administration of a computer network, ensuring the security of its functioning, etc. Network modeling can have significant potential in this regard, allowing students to experiment with network behavior and evaluate possible scenarios.

Network modeling is considered to be the reproduction of a dynamic image of the main components of the network and the visualization of the processes of their configuration and functioning on the computer screen. As an integral part of a comprehensive network modeling environment, it provides modeling, visualization, authoring, validation, and collaboration functions,

and facilitates the teaching and learning of complex technology principles. And it also complements the physical equipment of the classroom, allowing students to create networks with a virtually unlimited number of devices (Imputato, & Avallone, 2019; Lamps et al., 2018).

There are two main approaches to modeling computer networks: emulation and simulation. Emulation is a complex of software, hardware, or their combination, designed to copy the functions of one computing system to another, different from the first, so that the emulated behavior matches the behavior of the original system as closely as possible. Simulation concentrates on the recreation or reproduction of any of its key features or parameters (Coburn, Salmon & Freeman, 2018; Burgin, 2020).

At Abai Kazakh National Pedagogical University, for the training of informatics teachers in the field of computer networks and information security, the discipline «Computer networks and web technologies» is provided in the cycle of major disciplines, for the university component in accordance with the state compulsory education standard. The expected results on this subject suggest that future informatics teachers should know and be able to apply in their professional activities: the principles of building networks; network topology; purpose and basic principles of operation and configuration of network devices; levels of means of interaction of network devices; addressing in computer networks; routing in computer networks; use of web, DNS, DHCP servers; information security issues of computer networks; principles of operation of wireless networks, etc.

This will allow future informatics teachers to form knowledge about the forms and methods of information interaction, the importance of considering information security issues in the formation of information culture.

For conducting the research, we chose software environments that emulate or simulate the structure and functioning of computer networks (HP Network Simulator, eNSP, NetEmul, Cisco Packet Tracer) and augmented reality technology.

The above listed software environments allow creating networks of various topologies and structures by emulating network components (network cables, switches, routers, workstations, servers, etc.) and visualizing on a computer screen: the processes of configuring components and their interaction; processes of work of various network protocols; setting up a local area network and global Internet connection; as well as the functioning of the computer network as a whole. This ensures: determination of the optimal topology, adequate selection of network equipment, determination of the network performance; the impact of bursts of broadcast requests on the functioning of the network and determining the limit beyond which its «destruction» will go; possible stages of the future development of the network.

The use of augmented reality technology can significantly increase the effectiveness of teaching students' computer networks, since «this technology has a number of unique advantages, such as increased visibility, conducting previously impossible laboratory work, as well as increasing the degree of integration of information technologies into the educational process by reducing the limitations of modern computer user interfaces» (Grinshkun, 2018).

From the analysis of the functional capabilities of the above various software environments, it follows that they fully provide the opportunity for full and high-quality training of future informatics teachers in the field of computer networks, allowing them to solve professional problems in the design, maintenance, configuration and administration of computer networks.

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1.1. Purpose of study

Analysis of scientific and pedagogical and educational and methodological literature showed that educational institutions cannot fully provide the practical orientation of training in the field of computer networks, due to various difficulties when using real equipment and insufficient hardware resources of computers when using virtual machines (Fagerholm et al., 2018; El Motaki et al., 2019). On the basis of this, it was concluded that when teaching future informatics teachers about computer networks, it is necessary to use network modeling using software environments that simulate the structure and functioning of computer networks. To solve these problems and achieve the corresponding goals, within the framework of the described study, an attempt was made to improve the methodological systems of training and conduct training sessions with students of a pedagogical university in «Computer networks and web technologies» discipline on the basis of network modeling and subsequent measurement of the degree of influence of such a pedagogical approach on the effectiveness of training future informatics teachers.

2. Research methods

2.1. Data collection tool

A pedagogical experiment to assess the effectiveness of teaching future informatics teachers to computer networks based on network modeling was carried out from 2018-2020 on the basis of the Institute of Mathematics, Physics and Informatics of Abai Kazakh National Pedagogical University and Taraz Regional University named after M.Kh. Dulati.

Participants

The experiment involved 90 students studying in the direction of «Informatics». The content of training in the control and experimental groups was the same, in the experimental group it was supposed to use software environments that simulate the operation of a network, to apply augmented reality technology when organizing training in computer networks.

2.2. Analysis

Methods of mathematical statistics were used to process the results of the experimental part of the study.

2.3. *Data collection procedure*

During the experimental study, an analysis was made of the need for teaching computer networks and the capabilities of software environments based on network modeling for future informatics teachers and the problems of teaching computer networks in the training of future informatics teachers of in domestic and foreign studies. At the second stage of the study, the work on the implementation of the methodology for teaching computer networks based on network modeling was clarified, and the involvement of future informatics teachers in the teaching process was carried out. At the control stage, the results of the experiment of the methodology for teaching computer networks based on network modeling were generalized and worked out.

At the initial stage of the research (2018), the conditions for teaching computer networks were studied and analyzed for future informatics teachers, studying informatics at Abai Kazakh National Pedagogical University, students of the Taraz Regional University named after M.Kh. Dulati. The software and educational practice used in many pedagogical universities that participated in the experiment showed that future informatics teachers were not ready to teach topics that include working with computer networks in laboratory classes in teaching computer networks. During the research it was found that the traditionally used methodology does not allow solving the problems of teaching future informatics teachers in the practice of working with computer networks. After analyzing and summarizing the observations made, we came to the conclusion that it is necessary to teach computer networks based on network modeling for future informatics teachers who carry out training based on network modeling.

At the next stage of the research, the ways of teaching computer networks to future informatics teachers, ways of effective work with computer networks in practical classes were considered. At this stage of the experiment, a group of students was identified whose level of work with computer networks coincided with the level specified in the theoretical part of the study, which was carried out at Abai Kazakh National Pedagogical University and the Taraz Regional University named after M.Kh. Dulati.

At Abai Kazakh National Pedagogical University, in accordance with the state compulsory education standard in the field of training future teachers of in the Abai Kazakh National Pedagogical University, in accordance with the state compulsory education standard in the field of training future informatics teachers in the educational program of the specialty, the discipline «Computer networks and web technologies» was acquired in the profiling cycle, the group on the university component as a control group, and the group studying course «Computer networks and web technologies» using the proposed methodology, as an experimental group in the educational program of the specialty, the discipline «Computer networks and web technologies» was acquired in the profiling cycle, the group on the university component as a control group, and the group studying course «Computer networks and web technologies» using the proposed methodology, as an experimental group. The volume of the topics studied both in the control group and in the experimental group, in accordance with the volume of the state standard, formed the basis of the experiment. In particular, the results of the experiment on the topics covered were compared. In the course of practical exercises, the main subtleties of working with computer networks selected for research and the quality of their development were tested. The proposed material was to be assimilated by future informatics teachers of in the course of the next practical lessons using the developed methodological guidelines.

So, the first laboratory work was devoted to preliminary preparation of a PC for building a network, installing and initializing a network adapter, connecting a station to a network. As a result of laboratory work No.1, students will learn how to create a local network, set IP addresses, check how the local network is functioning correctly.

The second lab covers TCP/IP addressing and routing. In the course of laboratory work No.2, students must learn how to set up data transfer protocols, but the limited rights of both students and teachers do not give them the full opportunity to work with equipment and software.

The remaining laboratory works aimed at studying the computer network were organized in a similar way. In the course of the implementation of laboratory work, in addition to software environments, augmented reality technologies were applied when studying these types of network

cables of local networks, exchanging messages between computers and connecting devices Hub and Switch, identifying the differences between these devices. Augmented reality technology allows you to simultaneously see and use virtual and real objects in the world around a person. Allows students to visually see the exchange of messages between devices, device differences, types of network cables in 3D format, resize and easily remember types of network cables. This is especially true in distance learning, when the trainer cannot see this or that type of network cables «live». The use of augmented reality technology in teaching computer networks allows the teacher to present any object not only in volume, from the inside, but also in section, using a marker and serves to enhance the learning effect (maximum interactivity, visibility, deeper study, increasing student motivation, etc.).

The results of the experiment substantiated the fundamental implementation of the presented methodological materials and made it possible to outline the ways for their further improvement. Also, a methodology for teaching computer networks based on network modeling has been developed. In the course of the organization, the possibilities of mastering by students of control and experimental groups of software tools for working with computer networks were identified, the effectiveness of software environments for modeling networks was studied, which forms the basis of the proposed methodology.

The effectiveness of the methodology of teaching computer networks based on modeling networks of future informatics teachers is evidenced by the intermediate control of students' knowledge. At Abai KazNPU such control was carried out twice a semester from 2018 to 2020. In this case, practical exercises were conducted using augmented reality technologies and network modeling.

The purpose of the experiment is to identify the informational approaches of survey participants to the training of computer networks, to determine the effective directions of software for modeling networks, augmented reality technologies, to substantiate the effectiveness of coordination and integration of software in accordance with the positions established by the developed information model. In accordance with the formulated goal, 56 students took part in the survey, these are future teachers of informatics of Abai KazNPU. All students had the same opportunities to work with computer networks, augmented reality technologies.

A special survey was created for students, which took into account the interaction of students with computer networks, augmented reality technologies.

The first and main result of the questionnaire is a qualitative analysis of all the answers carried out in order to identify the general picture of informatization of Abai KazNPU, directions and shortcomings of the development of teaching informatics in the context of computer networks and augmented reality technologies, qualitative argumentation of the effectiveness of its practical application. In addition, within the framework of the study, a quantitative analysis was carried out - a comparison, during which there was an increase in interest in the practical application of software environments, the involvement of students in the general process of informatization of education.

During the research the questionnaire questions were asked in three stages, making up six months and a year for the permanent composition of students without changes. The survey was attended by the above-described composition of students who at that time studied at the 3rd and 4th courses of Abai KazNPU.

3. Results and discussion

The processing of the completed questionnaires was carried out by determining the coefficient *k* for each student according to the formula:

k=10*a+5*b+c, here

a - the number of questions to which item «A» was selected when answering;

b-the number of questions to which item «B» was selected when answering;

c - the number of questions to which item «C» was selected when answering;

10, 5 and 1 were introduced by the study author to differentiate and scale the response results. The structure of the survey is as follows: the choice of type «A» answers by survey participants indicates a high level of application of software tools for network modeling, augmented reality technologies. The structure of the survey is as follows: the choice of type «A» answers by the survey participants indicates a high level of application of software tools for modeling networks, augmented reality technologies, the choice of type «B» answers - at the middle level, the choice of type «C» answers - that in practice, software tools for network modeling and augmented reality technologies are not used. In this regard, the calculated coefficient k will be higher only if the number of answers of type «A» is greater. On the contrary, the lower indicator of the coefficient k will be in the event that the respondent chooses option «C» for all questions. It is noteworthy that all three swing multipliers are free-form. The main condition is that the first multiplier is greater than the second, and the second is greater than the third. In this case, the scale factors selected during the examination not only satisfy this requirement, but are also uniformly distributed (each subsequent number is 5 more than the previous one).

As the arithmetic mean of the coefficients for all students who took part in the survey at each of the 3 stages of analysis, k_{av} is calculated by the formula:

$k_{av} =(k_1+k_2+…+ k_n)/h$, where

k_n – k is the coefficient obtained during testing each student in one stage, and h is the total number of students.

In order to reduce the procedure for comparing the results of the questionnaire, conditional levels of use of information resources and environmental components have been established for each stage:

High level-$110 \leq k_{av} \leq 160$,

Medium level-$60 \leq k_{av} \leq 110$,

Low level-$16 \leq k_{av} \leq 60$

Within the framework of this study, the individual results of each student at each stage of the questionnaire are not considered. Only the general results of each stage, obtained when calculating k_{av}, are considered. Such results contributed to the proof of the research hypothesis in the general experiment. The result of the experiment for each stage is shown in the Fig.1 below.

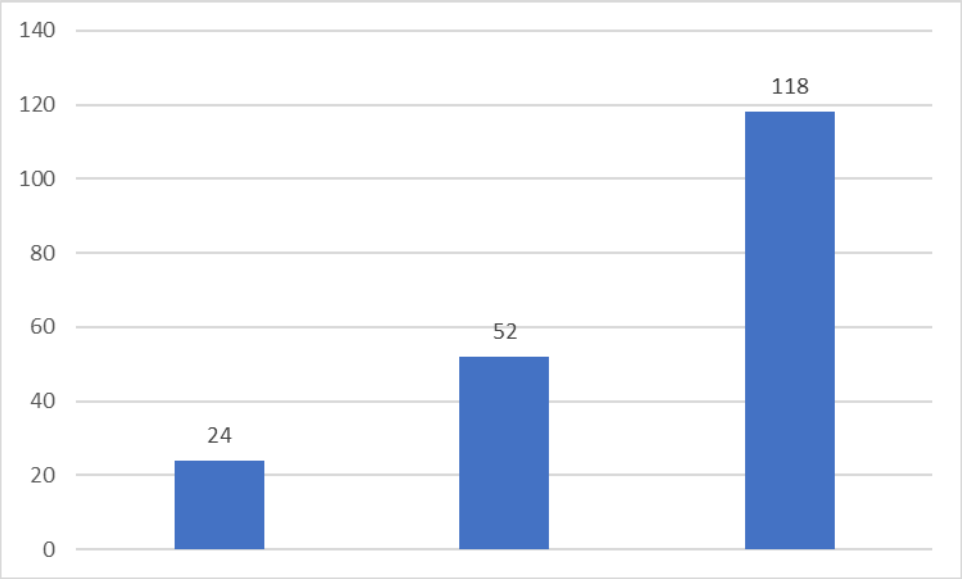

Figure 1. Review results

At the first stage of the examination, k_{av} was equal to 24, which corresponds to a lower degree of student involvement in the use of information resources integrated into the environment.

The coefficient k_{av}, determined during the second stage, was 52, which is higher than in the previous result, although it does not allow us to speak of a lower level of experimental exploitation of the environment. But when conducting a survey of the same students at the third stage, the value of the coefficient k_{av} according to the same survey reached 118, which allows us to speak of a high degree of student involvement in the use of network modeling software, augmented reality technologies in teaching computer networks to future teachers of informatics.

The use of network modeling software, augmented reality technologies in teaching computer networks brings knowledge of computer science to a qualitatively new level.

Control exam was carried out in 2019-2020. Taraz Regional University named after M.Kh. Dulati in Taraz) One experiment and one control group of 3rd year students of Abai KazNPU. In the experimental group (45 students), the lesson was conducted according to the methodology developed by us, teaching computer networks based on network modeling software, augmented reality technologies, and in the control group (45 students) the lesson was conducted according to the traditional method. In turn, the lessons were in the form of theoretical and practical lessons. All experimental work was carried out during classes with students.

One of the types of assessment of the level of mastering a topic by students is to consolidate the knowledge gained in daily classes, i.e., a survey, giving examples, completing tasks, and the second is a test method of knowledge control, which is widely used today. We also used this testing method in this experiment.

The advantage of the test method over the control methods is that it becomes possible to systematically, complete control of the student's knowledge in a certain section, it is possible to

determine what knowledge he has about the basic concepts and conclusions. Develops the thinking of students.

The criterion for assessing knowledge is the correct answer to each question with one point, the sum of these points is received as the only indicator of the student's knowledge (Babansky, 1978). The relative indicator of test results is determined by the formula:

K=(P/N)*100% (1)

Where, N is the total number of test questions asked,

P is the number of correct answers,

K-score scored by the student.

The assessment method was assessed according to the following indicator, assigned on the basis of the universal method for testing the knowledge and skills of the student - the statistical method:

«excellent», if 81%≤κ≤100%

«good», if 61%≤κ≤80%

«middle», if 41%≤κ≤60%

«bad», if κ≤40%

This is a statement supported by special scientific research.

The result of the experimental work showed that teaching computer networks with the help of the methodology developed by us reaches a higher level. The levels of mastering the topic by the students were determined according to the results of the test method of checking knowledge and were calculated according to Formula (1), as shown in the ascertaining experiment. The results of the experiment show that the quality of knowledge of the experimental group is higher than that of the control group. Now let us show the level of assimilation of knowledge by students of both groups in table 1.

Table 1 : *the level of students' assimilation of knowledge in computer science*

University name	Group type	Marks			
		5	4	3	2
Abai KazNPU	Control group (20 student)	2 (10%)	4 (20%)	11 (55%)	3 (15%)
	Experimental group (20 student)	4 (20%)	12 (60%)	4 (20%)	0 (0,00%)
Taraz Regional University named after M. Kh. Dulati	Control group (25 student)	4 (16%)	3 (12%)	12 (48%)	6 (24%)
	Experimental group (25 student)	9 (36%)	11 (44%)	5 (20%)	0 (0,00%)

Let us describe the results of students' knowledge in the control and experimental groups, as in Fig. 2.

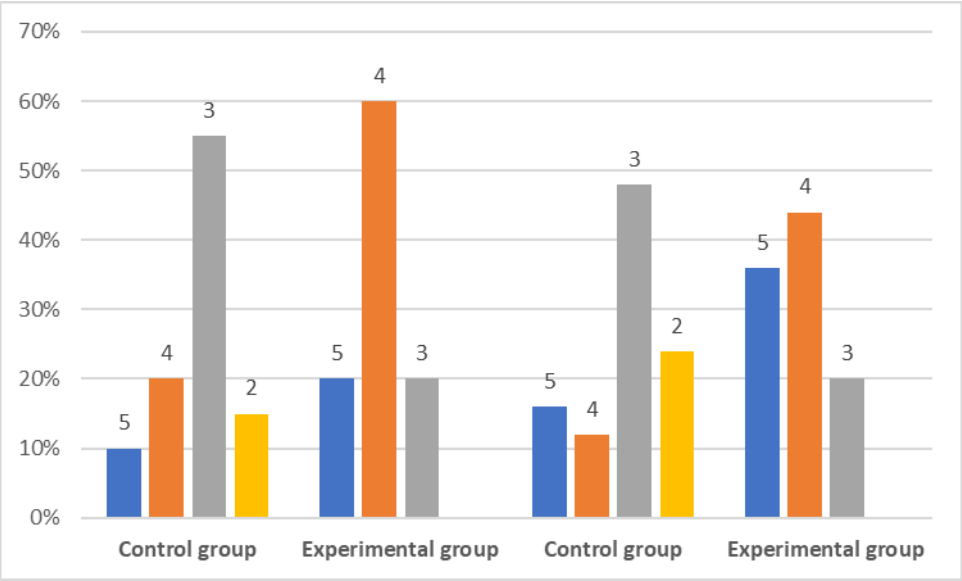

Figure 2. Results of students' knowledge in the control and experimental groups

The experimental experiment showed that the average score of knowledge of the experimental groups was significantly higher than in the control groups.

Thus, it was found that the development and implementation of the proposed teaching methodology provides an opportunity for full and high-quality training of future teachers of informatics in the field of computer networks, which allows them to solve professional problems in the design, maintenance, configuration and administration of computer networks. The experience of using the proposed methodology confirms their positive impact on the effectiveness of teaching future teachers of informatics computer networks based on network modeling.

4. Conclusion

Based on the pedagogical goals of using software environments for simulating network equipment of computer networks and augmented reality technologies, we can conclude that with the help of such software environments and augmented reality technologies, it is possible to create various topologies and structures by emulating network components (network cables, switches, routers, workstations, servers, etc.). In addition, visualization on a computer screen allows the following processes: configuration of components and their interaction; operation of various network protocols; local network and global Internet; as well as the determination of the functioning of the computer network as a whole, the optimal topology, the appropriate choice of network equipment, the determination of the operating characteristics of the network; possible options for building a network in the future.

During the research it showed that learning with the help of the methodology developed by us has reached a high level. The results of the experiment show that the quality of knowledge of the experimental group is higher than that of the control group.

References

Babansky, A.S. (1978). *Statistical methods in pedagogy and psychology.* Moscow: Mir.

Burgin, M. (2020). Triadic automata and machines as information transformers. *Information (Switzerland)*, 11(2), article number 102. https://www.mdpi.com/640668

Calle, M.A., Tovar, J.D., Castaño-Pino, Y.J., Cuéllar, J.C. (2018). Comparison of parameters for an appropriate selection of network simulation tools. *Informacion Tecnologica*, 29(6), 253-266. https://scielo.conicyt.cl/scielo.php?pid=S0718-07642018000600253&script=sci_arttext

Coburn, J.Q., Salmon, J.L., Freeman, I. (2018). Effectiveness of an immersive virtual environment for collaboration with gesture support using low-cost hardware. *Journal of Mechanical Design, Transactions of the ASME*, 140(4), article number 042001. https://asmedigitalcollection.asme.org/mechanicaldesign/article/140/4/042001/376129

Damekova, S.K. (2008). *Improving the methodology of teaching future teachers of informatics in the basics of telecommunication networks using the educational site*: thesis of the candidate of pedagogical sciences. Almaty: Abai Kazakh National Pedagogical University

El Motaki, S., Yahyaouy, A., Gualous, H., Sabor, J. (2019). Comparative study between exact and metaheuristic approaches for virtual machine placement process as knapsack problem. *Journal of Supercomputing*, 75(10), 6239-6259. https://tinyurl.com/yhhe6lzd

Fagerholm, F., Hellas, A., Luukkainen, M., Kyllönen, K., Yaman, S., Mäenpää, H. (2018). Designing and implementing an environment for software start-up education: Patterns and anti- patterns. *Journal of Systems and Software*, 146, 1-13. https://www.sciencedirect.com/science/article/pii/S0164121218301742

Fakhar, F. (2019). Investigate network simulation tools in designing and managing intelligent systems. *Journal of Information Systems and Telecommunication*, 7(4), 278-293. https://www.sid.ir/FileServer/JE/5055520192801

Grinshkun A.V. (2018). Augmented reality technology as an object of study and a means of teaching in a basic school computer science course: thesis dis. Can.Ped.Sci.: 13.00.02. - Moscow, 2018. - 24 p.

Imputato, P., Avallone, S. (2019). Enhancing the fidelity of network emulation through direct access to device buffers. *Journal of Network and Computer Applications*, 130, 63-75. https://www.sciencedirect.com/science/article/pii/S1084804519300220?casa_token=WVSx041eewcAAAAA:-qOdMsnprRkT4JX81vCjta3mjGQKHpea-L0FNtVGjAzz8TwXTNckczfF4ZxsZ-auj3YLMpxd0Cnq

Lamps, J., Babu, V., Nicol, D.M., Adam, V., Kumar, R. (2018). Temporal integration of emulation and network simulators on linux multiprocessors. *ACM Transactions on Modeling and Computer Simulation*, 28(1), article number 1. https://dl.acm.org/doi/abs/10.1145/3154386

Lyaginova, O.Yu. (2011). *Teaching informatics teachers to model hardware and software of a computer and an information network based on specialized software environments*: thesis of the candidate of pedagogical sciences. Moscow: Institute of Informatization of Education of the Russian Academy of Education. https://www.kaznpu.kz/kz/1289/page/

Lyash, O.I. (2008). *Methods of teaching future teachers of informatics network technologies using virtual machines*: thesis of the candidate of pedagogical sciences. Murmansk: Murmansk State Pedagogical University.

Mogilev, A.V., Pak, N.I., Hönner, E.K. (2004). *Informatics.* Moscow: Akademiya.

Nagyová, I. (2018). Analysing the different approaches in mathematics and informatics for solving a task and educational implications. *Informatics in Education*, 17(1), 61-75. https://www.ceeol.com/search/article-detail?id=645611

Nikitin, P.V., Melnikova, A.I., Gorokhova, R.I. (2014). Methodological features of training future teachers of informatics in the discipline "Computer networks, Internet and multimedia technologies". *Modern Problems of Science and Education*, 4. https://www.science- education.ru/ru/article/view?id=14054

Olifer, V., Olifer, N. (2016). *Computer networks. Principles, technologies, protocols.* Saint Petersburg: Piter. https://bitserv.ru/en/kniga-kompyuternye-seti-olifer-v-g-olifer-n-a-kompyuternye-seti/

Sergeev, A. (2016). *Basics of local computer networks.* Saint Petersburg: Lan.

Shestopalova, O.A. (2014). *Methodological approaches to teaching network technologies based on imitating the functioning of hardware and software (on the example of a specialized course in computer science and ICT)*: thesis of the candidate of pedagogical sciences. Nizhnevartovsk: Nizhnevartovsk State University. https://tinyurl.com/yj85cn25

Tagaeva, G., Mamytov, A., Kenzhebay, R., Labenova, R., Alimbaeva, A., Kylyshbaeva, G., ... & Torybaeva, J. (2018). A typical curriculum on the subject "Informatics" for grades 5-9 of the level of basic secondaryeducation on the updated content. (2018). https://infourok.ru/tipovaya-uchebnaya-programma-po-uchebnomu-predmetu-informatika-dlya-klassov-urovnya-osnovnogo-srednego- obrazovaniya-po-obnovlenn-2558144.html

Yakymchuk, N.V., Kazachenok, V.V. (2018). Developing cognitive independence of future informatics teachers by multimedia tools. *European Journal of Contemporary Education*, 7(3), 581-597. https://eric.ed.gov/?id=EJ1192134