

# 9th Workshop on Cloud Technologies in Education: Report

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**Abstract.** This is an introductory text to a collection of selected papers from the 9th Workshop on Cloud Technologies in Education (CTE 2021) which held in Kryvyi Rih, Ukraine, on the December 17, 2021. It consists of short introduction, papers' review and some observations about the event and its future.

**Keywords:** Adaptive Cloud Learning Platforms, Blended Learning, Blockchain in Education, Cloud-based AI Education Applications, Cloud-based E-learning Platforms, Tools and Services, Cloud-based Learning Environments, Competency-Based Education Platforms, Digital Transformation of Education, Educational Data Mining, Emotion AI, Immersive Technology Applications in Education, Mobile Learning, Smart Campus Technologies, Social Analytics in Education

## 1. Introduction

### 1.1. CTE 2021: At a glance

Cloud Technologies in Education (CTE) is a peer-reviewed international Computer Science workshop focusing on research advances, applications of cloud technology in education.

The Workshop occupies contributions in all aspects of educational technologies and cloud-based learning tools, platforms, paradigms and models, functioning programmes or papers relevant to modern engineering and technological decisions in the IT age.

CTE topics of interest since 2017 [77, 81, 82, 183]:

- Adaptive Cloud Learning Platforms
- Blended Learning
- Blockchain in Education
- Cloud-based AI Education Applications
- Cloud-based E-learning Platforms, Tools and Services
- Cloud-based Learning Environments
- Competency-Based Education Platforms
- Digital Transformation of Education
- Educational Data Mining
- Emotion AI
- Immersive Technology Applications in Education
- Mobile Learning
- Smart Campus Technologies



Figure 1: CTE 2021 logo.

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- Social Analytics in Education

This volume represents the proceedings of the 9th Workshop on Cloud Technologies in Education (CTE 2021), held in Ukraine, Ukraine, on December 17, 2021. It comprises 26 contributed paper that were carefully peer-reviewed and selected from 37 submissions (<https://notso.easyscience.education/cte/2021/>). Each submission was reviewed by at least 3 program committee members. The accepted paper present the state-of-the-art overview of successful cases and provides guidelines for future research.

The volume is structured in six parts, each presenting the contributions for a particular workshop session.

## 1.2. CTE 2021 Program Committee

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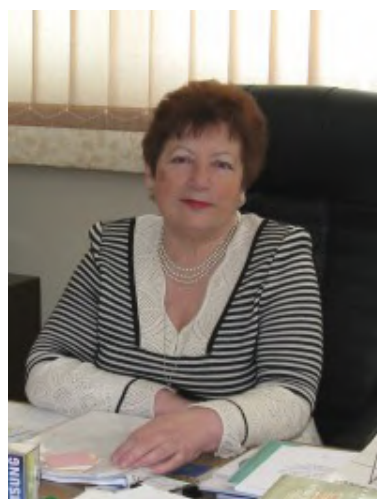
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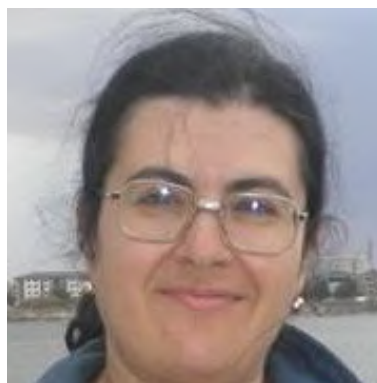
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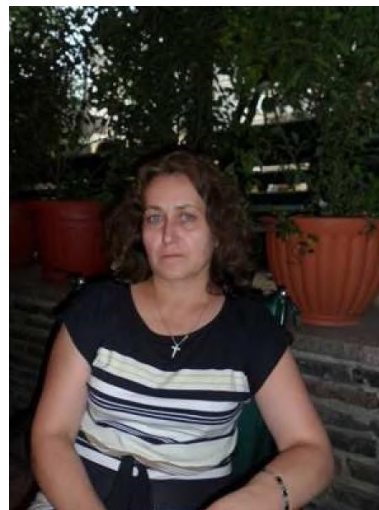


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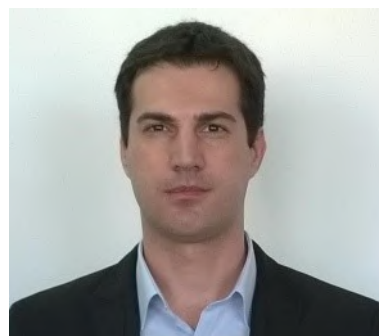
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## 2. Articles overview

### 2.1. Session 1: Digital Transformation of Education

Digital technology permeates all aspects of life. During the pandemic, all countries in the world began to use distance learning methods through the use of digital platforms, classes, labs. Digitalization avoided the collapse of the educational system. The aim of the article “Problematic issues of digitalization of education in Eastern Europe” [192] by Anastasiia O. Simakhova (figure 2), Artem E. Artyukhov, Halina A. Shmarlouskaya is to analyze the processes of digitization of education in Eastern Europe. To achieve the goal of the article, the following tasks were set: to study the theoretical basis of the digitization of education, to analyze the trends in the digitization of education in Eastern Europe, to develop recommendations for improving the digitization of education. The article analyzed the ranks of the Network Readiness Index and the Global Digital Readiness Index in terms of the technological readiness of higher education institutions and students for distance education. The article offers a case study of the Ukrainian university for the implementation of an e-learning environment. The authors grouped countries from Eastern Europe according to their potential for digitizing education. For these groups of countries, the authors identified specific criteria. SWOT an analysis of the digitization of education was conducted for the countries of Eastern Europe.

In the article “The use of digital tools by secondary school teachers for the implementation of distance learning in the context of digital transformation in Ukraine” [156], Oksana V. Ovcharuk, Andrii M. Gurzhii, Iryna V. Ivaniuk, Liubov A. Kartashova, Olena O. Hrytsenchuk, Tetiana A. Vakaliuk, Mariya P. Shyshkina (figure 3) raise the discussion on the use of digital learning tools

**Problematic issues of digitalization of education in Eastern Europe**

Anastasiia Simakhova, National Aviation University;  
Artem Artyukhov, Sumy State University;  
Halina Shmarlouskaya, Belarusian State Economic University



**E-learning environment: Sumy State University case (Ukraine)**



### Algorithm for creating educational materials

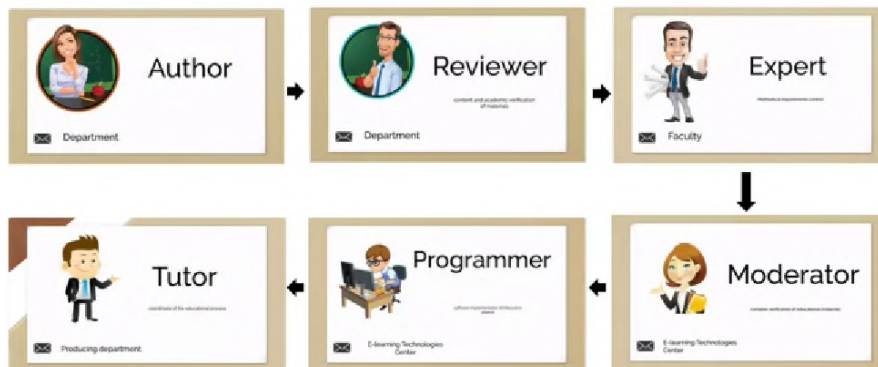


Figure 2: Presentation of paper [192].

by teachers of Ukrainian secondary schools for the organization of distance learning. In order to collect data authors have used the survey instruments (Google questionnaire) and involved



1463 respondents who revealed the state of the use of digital learning tools for the organization of distance learning in the quarantine period caused by COVID-19 pandemic. The study was conducted in all regions of Ukraine. The results show that teachers have a need to master their knowledge and practical skills on digital instruments for the organization of distance learning with students. On the other hand the paper presents the experience on how the problem of the mastering of teachers' digital competencies can be organized and what are the steps to the organization of special distance learning courses for teachers in Ukraine. The experience of the creation of Web portal of Ukrainian Open University of Postgraduate Education is presented. Authors propose on how the needs and requirements of teachers regarding the implementation of the distance learning in schools and the development of their digital competencies should be resolved.

This article highlights further research by the authors, begun in [2, 12, 35, 50, 69, 70, 87, 144, 154, 155, 157, 217, 220, 241, 245, 251].

The problems of contemporary IT specialists' training in terms of the high requirements to their computational thinking skills as well as the urgency of raising their motivation to mastering algorithmization and programming are discussed in the article "Computer modeling of the tournament of game algorithms in the process of learning of basics of algorithmization and programming by pre-service IT-specialists" [55]. It is emphasized by Liudmyla E. Gryzun (figure 4), Oleksandr V. Shcherbakov and Svitlana H. Lytvynova that initial university courses should focus pre-service IT-specialists on the deep understanding of an algorithmic nature of any coding task, to realize basic characteristics of the algorithms, to understand their role in modern software development. Due to the contemporary demands, programming should rest on algorithms building and has to be a part of larger scale experiences in order to realize its full potential. One of such experiences offered by the authors in the paper is involving the students into specially arranged activity focused on efficient game algorithms creation and simulation of the tournament between the algorithms. The offered activity is elaborated based on the applying the gamification elements into the learning process. Basing on the core gamification principles, there were thought over and arranged an activity involving the students into the creation of gamified products. In this case, the gamified product which the students had to develop in the process of learning of algorithmization and programming was the software platform which enables a computer simulation of the tournament between the different game algorithms which realize winning strategies. The peculiarities and the stages of the said activity are covered in details along with the description of the final software product. Analyzing the described functionality of the computer simulator of the algorithms tournaments based on the gamification ideas, authors can emphasize its significant didactic facilities in the context of its using for IT-specialists training. In particular, the developed gamified product was probed in the process of other students' mastering algorithmization and programming as well as of the schoolchildren training during summer IT schools. The prospects of the research are outlined in the lines of using the obtained results for holding the empirical research for the verification of offered activity impact on the results of IT-specialists training.

This article highlights further research by the authors, begun in [8, 20–24, 26, 115, 167, 232].

The aim of the article "ICT and current trends as a path to STEM education: implementation and prospects" [110] by Natalia S. Lukychova (figure 5), Nataliia V. Osypova, Galina S. Yuzbashaeva is to build a model for the introduction of STEM education in institutions of general



## The use of digital tools by secondary school teachers for the implementation of distance learning in the context of digital transformation in Ukraine

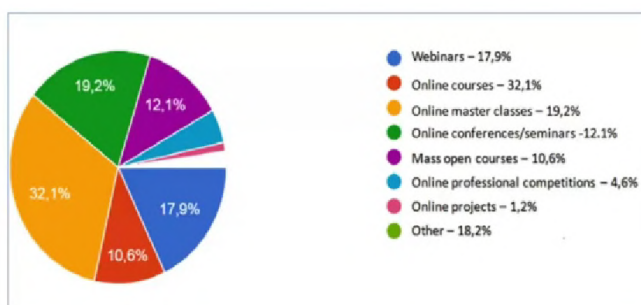


*Oksana Ovcharuk, Iryna Ivaniuk, Olena Hrytsenchuk, Andrii Gurzhii, Lubov Kartashova, Tetiana Vakaliuk, Mariia Shyskina*  
 Institute of Information Technologies and Learning Tools of the NAES of Ukraine. Kyiv, Ukraine

9th Workshop on Cloud Technologies in Education (CTE 2021)

### The most effective online forms of professional development

- online courses - 32.1%
- online master classes - 19.2%
- webinars - 17.9%
- online conferences / seminars - 12.1%
- mass open courses - 10.6%
- online professional competitions - 4.6%



#### Good practices

3D Democracy: think, care, act' (<https://citizen.in.ua/about.php>), created by NGO 'Nova Doba' with the support of USAID, MoES and others

Figure 3: Presentation of paper [156].

CTE 2021 17 DECEMBER 2021 / KRYVYI RIH, UKRAINE  
The 9th Workshop on Cloud Technologies in Education

### Computer modeling of the tournament of game algorithms in the process of learning of basics of algorithmization and programming by pre-service IT-specialists

Prof. Liudmyla Gryzun, prof. Oleksandr Shcherbakov  
Simon Kuznets Kharkiv national university of economics,  
Information Systems Department

Svitlana Lytvynova,  
Institute of Information Technologies and Learning Tools of National  
Academy of Educational Sciences of Ukraine

#### The preparation stage of the activity on creation the gamified product

The task for the students was specified as following: to develop a computer simulator of the tournament between the different game algorithms which realize winning strategies.

The peculiarity of the task is to model the game process where the competitors are different algorithms but not a computer and humans (or humans controlled by a computer).

#### Simulation of the tournament of Tic tac toe-game. Choosing the algorithms and parameters of their visualization

Ввод  
Название алгоритма:  
Algorithm1  
Cancel OK

Figure 4: Presentation of paper [55].

secondary education, to demonstrate the experience of using ICT in STEM education. Analysis of scientific publications makes it possible to determine the role and place of ICT in the model

of introduction of STEM education in general secondary education institutions. The presented experience of the systemic implementation of STEM education in general secondary education institutions allows the formation of professional competencies of teachers in the field of STEM education and can be useful in their professional activities. The study shows that the systemic implementation of STEM technologies in the educational process increases the effectiveness of training, the level of motivation of participants in the educational process and the quality of knowledge in the subjects of the natural science cycle, and also contributes to the formation of key competencies of students.

This article highlights further research by the authors, begun in [99, 152, 153].

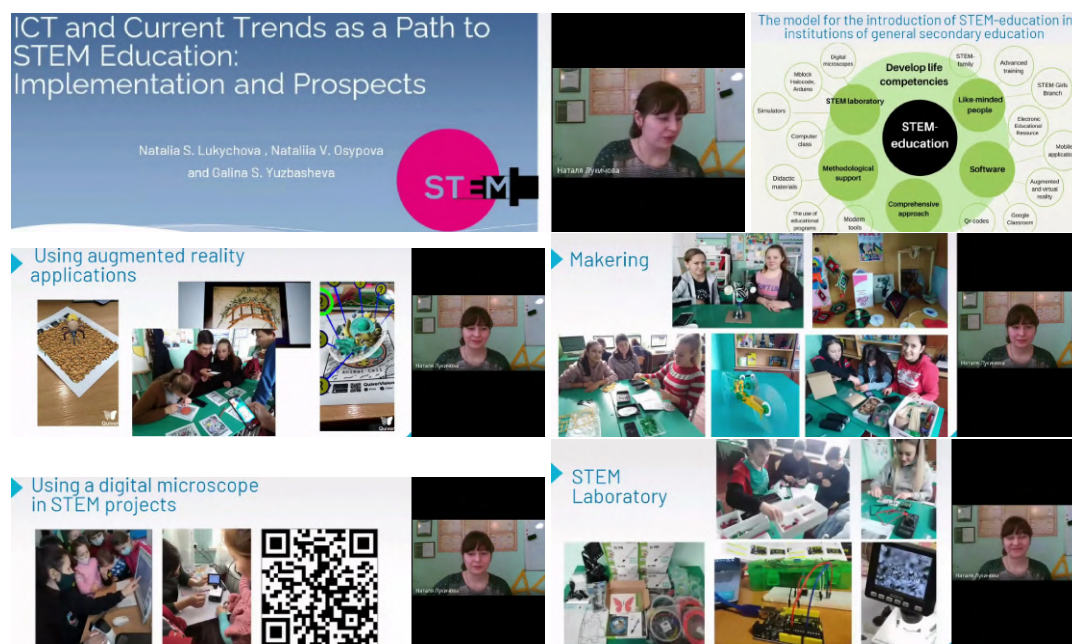


Figure 5: Presentation of paper [110].

Synergetics as a scientific area of research is in demand by society. The context of synergetics makes it possible for scientists of different specializations to interact fruitfully in the language of systematic understanding and search for new solutions. The article “Complex systems and physics education” [17] by Andrii O. Bielinskyi (figure 6), Arnold E. Kiv, Yuliya O. Prikhozha, Mykola A. Slusarenko, Vladimir N. Soloviev raises the question of how the theory of self-organization can help in the reformation of the higher education system, why this is relevant, and what can lead to the training of both teachers and students within the framework of an interdisciplinary approach. In the future, authors will highlight the most important characteristics of complex systems and the simplest and at the same time conceptually simplest methods for analyzing complexity. As part of the complex systems modeling course, which will first be presented to students of physics and mathematics, and then, possibly, to students of other specialties, authors present signals of seismic activity, gravitational waves and magnetic activity, and demonstrate how authors can identify critical or crash phenomena in such systems.



This kind of analysis can serve as a good basis for the formation of professional skills and universal competencies.

This article highlights further research by the authors, begun in [13–15, 18, 29, 43, 47, 80, 84, 86, 92, 93, 137, 195, 235].

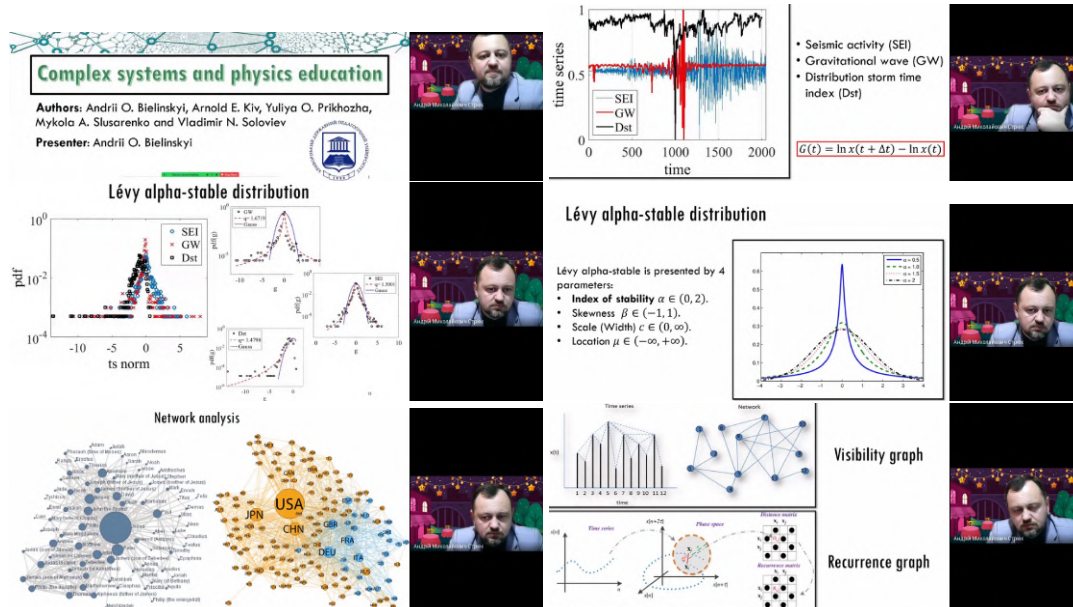


Figure 6: Presentation of paper [17].

The article “Agile methodology in higher education quality assurance system for SDGs 4, 8 and 9 achievement: national experience” [4] is focused on considering agile methodology as an instrument to use in education quality assurance. Artem E. Artyukhov, Iurii Iu. Volk (figure 7) and Tetiana A. Vasylieva propose the Scrum method applicable for education quality assurance based on adapted Manifesto for Agile Education Quality Assurance and twelve principles behind it. The Scrum procedure is described and roles are distributed for two real-life cases of external and internal educational program quality evaluation. Authors illustrate that proposed Scrum procedure perfectly fits existing practices and can be used to enhance both external and internal quality assurance processes in higher education. Authors consider achievement of SDG 4 targets through proposed methodology as the necessary step to take in achieving SDGs 8 and 9. It is concluded that stakeholders feedback about their satisfaction by economic and innovative factors should be included in each sprint review procedure in proposed Scrum methodology. Authors discuss SDG 4 achieving within multilayered DIKW+DM hierarchy as a framework for education quality assurance that allow to join information processing, knowledge acquisition and corresponding decision-making algorithm.

Today in most countries there is a lack of qualifications in areas, which require specialists with mathematical competencies, despite the high unemployment rate in many countries. At the same time, it is generally recognized that most likely those sciences are developing, the fundamental results of which can be formulated mathematically. Using mathematical methods,



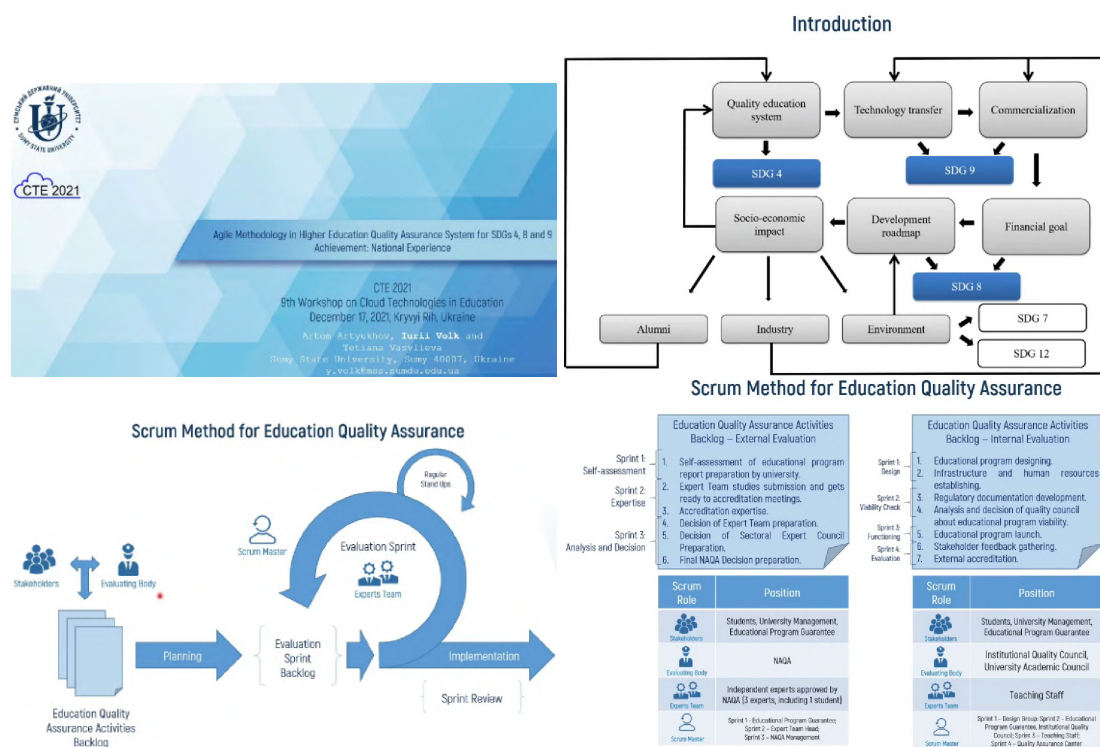


Figure 7: Presentation of paper [4].

Nataliia V. Morze, Iryna V. Mashkina (figure 8) and Mariia A. Boiko draw important conclusions that could hardly be obtained otherwise. Digital transformation of all industries requires specialists with a sufficient level of mathematical competence and skills in ICT tools, including computer modeling using the approach called Inquiry-Based Mathematics Education (IBME).

This article highlights further research by the authors, begun in [51, 52, 116, 117, 135].

Modern society is characterized by a significant impact of information technologies on all spheres of human life. In a special way, the processes of digital transformation affect educational institutions, including vocational (vocational and technical) ones. Now vocational (vocational and technical) education occupies an important place in the sector of the country's economy, prioritizing effective training of highly qualified labourers in the state policy of Ukraine. Nowadays, the professional activity of labourers incorporates an intellectual component related to working with electronic devices, artificial intelligence systems, etc. Monitoring of the labor market shows that a skilled worker of the XXI century should be able to think critically, process information analytically, and work with mechatronics systems. The analysis of the European experience in training qualified workers reflects a certain lag of domestic institutions in terms of digital supply. At the same time, the level of teachers' digital competence at vocational (vocational and technical) education institutions needs improving. As a result, the issues of digital transformation for educational institutions are urgent and topical [94]. Provision of modern digital equipment, formation and development of digital competence of all participants in the educational space are becoming the main tasks of teaching staff in the current conditions.

### Experience in training specialists with mathematical computer modeling skills, taking into account the needs of the modern labor market

*Nataliia Morze, Iryna Mashkina, Mariia Boiko*

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### Survey results

#### Direction of activity of enterprises

#### Does your company have an additional need for such specialists?

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### Development of Student Business Incubator

**Student Business Incubator**

- Changing approaches to teaching math through Workshops

**Questionnaire for enterprises, business companies**

- Creating tasks on mathematical modeling
- Task database update

**Course "Math in real life"**

**Questionnaire about using of IBL in mathematics education**

**Questionnaire for graduates**

- To teach mathematical modeling related to the Inquiry
- To use mathematical models to solve practical problems
- To implement innovations by involving the students to develop the Start-ups.

Figure 8: Presentation of paper [133].

In a special way, the tasks set become relevant during the period of quarantine restrictions, when educational institutions mainly work on distance and mixed forms of teaching.

This article highlights further research by the authors, begun in [33, 66, 100, 101, 112, 113, 121, 122, 129, 173, 177, 197].



Figure 9: Presentation of paper [94].

## 2.2. Session 2: Competency-Based Education Platforms and Social Analytics in Education

The article “Social dimension of higher education: definition, indicators, models” [162] by Liubov F. Panchenko (figure 10), Hennadii O. Korzhov, Andrii O. Khomiak, Vladyslav Ye. Velychko and Vladimir N. Soloviev deals with the problem of strengthening the social dimension of higher education. It discusses the definition of social dimension, its indicators, models of student retention and student engagement. The article argues that students should act as active researchers of the topic of social dimension and present the ways to update the content of university courses for Sociology majors, such as “Mathematical and statistical methods of social information analysis”, “Social statistics and demography”, “Multivariate data analysis”, “Structural equation modeling” and other courses for bachelors, master students, and PhDs in Sociology.

This article highlights further research by the authors, begun in [44, 74, 78, 79, 85, 159–161, 163–166, 198, 235, 237–239].

One of the indicators of the influence and competitiveness of university is participation in international and local rankings. In the methodologies of the most authoritative rankings, the quality and transparency of Universities is assessed by indicators of the university teachers’ publishing activity. The article “Designing a rating system based on competencies for the analysis of the University teachers’ research activities” [131] by Nataliia V. Morze, Oksana P. Buinytska, Valeriia A. Smirnova (figure 11) analyzes the experience of designing systems that analyses university teachers research activities, tools and components of evaluating the effectiveness of research, designed a structural and functional model of rating system for the analysis the university teachers’ research activities taking into account research and digital competencies. The developed model provides performance of the basic functions and allows for systematic monitoring of openness, transparency, efficiency of the research component of



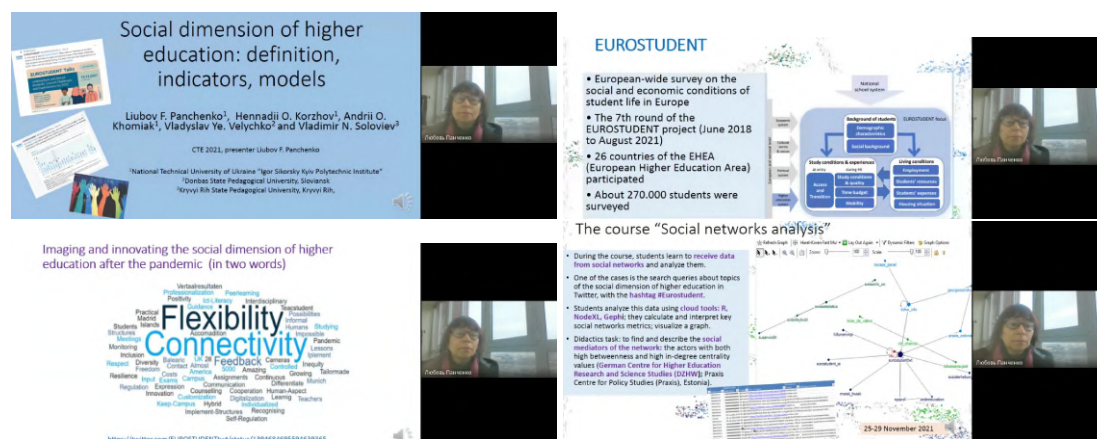


Figure 10: Presentation of paper [162].

university teachers' professional activity. The model was based on key indicators for evaluating the effectiveness of research – citation indicators of the three most important scientometric databases – Scopus, Web of Science, Google Scholar. The connection between the indicators presented in the model forms a portrait of the university teachers' scientific activity, gives an overall assessment of productivity, influence and contribution to the research direction of the university as a whole. The article describes 1 stage of implementation of the presented model by developing a “Rating of Transparency of Structural Units”, the effectiveness of experimental ranking. The study has established the positive impact of the implementation of the rating system, identified the main activities to increase the visibility, presence, dissemination of research results, the systematic implementation of which contributes to the optimal representation of the scientist in the rating evaluation of the research component of the university teachers professional activities, improving the digital competence of teachers and positively affects the quality indicators of the university scientific work in local and international rankings, as the existence of the system and the formation of ratings is an incentive for university teachers to present and disseminate their own publishing activities in the international online scientific community.

This article highlights further research by the authors, begun in [49, 130, 132, 134].

### 2.3. Session 3: Cloud-based AI Education Applications

In the process of self-assessment and accreditation examination, assessment is carried out according to a scale that covers four levels of compliance with the quality criteria of the educational program and educational activities. Assessing the quality of education is complicated by the fact that the value of quality criteria is due to a large number of factors, possibly with an unknown nature of influence, as well as the fact that when conducting pedagogical measurements it is necessary to work with non-numerical information. To solve these problems, the Andriy V. Ryabko (figure 12), Oksana V. Zaika, Roman P. Kukharchuk, Tetiana A. Vakaliuk and Viacheslav V. Osadchyi proposed a method for assessing the quality of educational programs



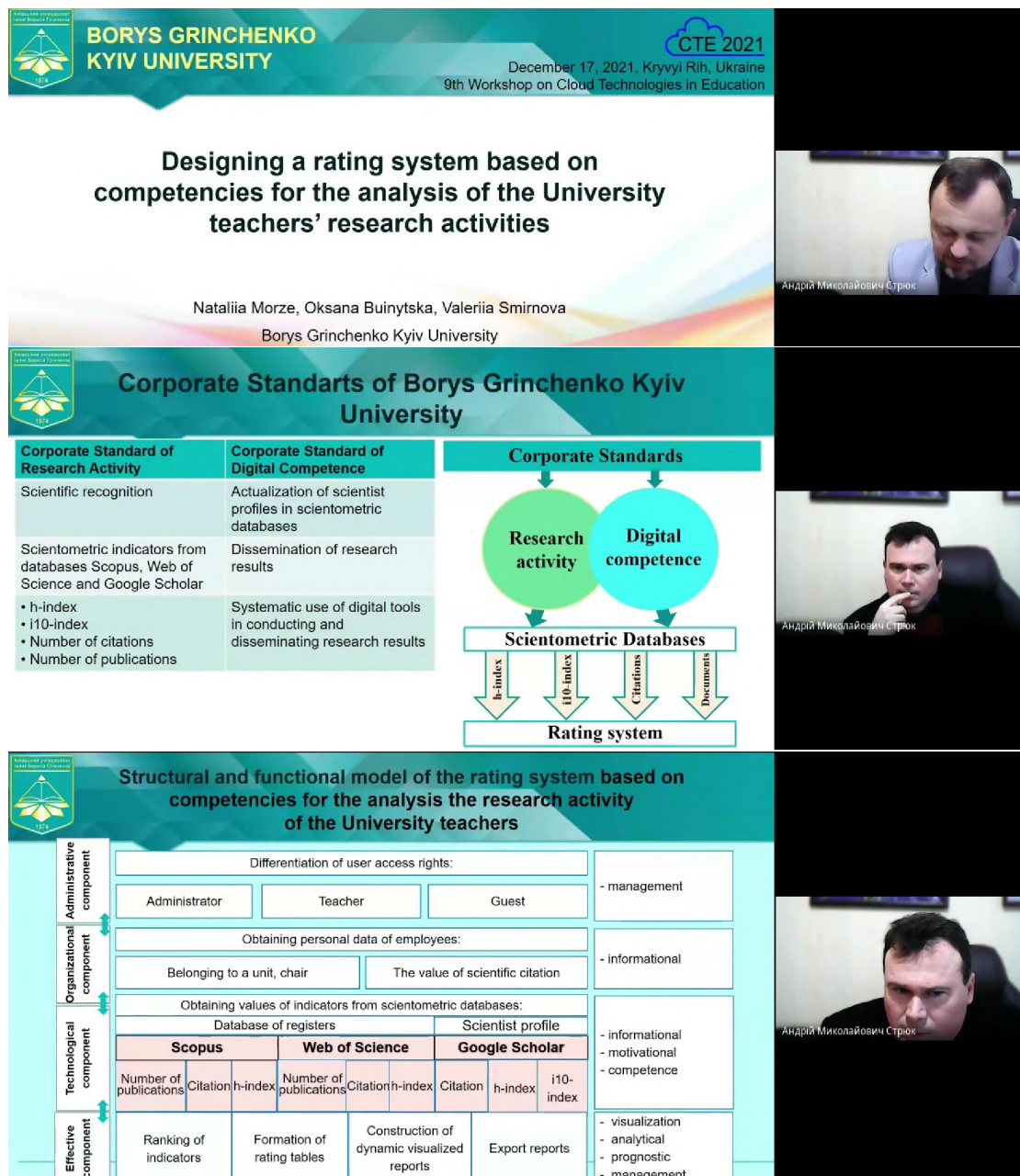


Figure 11: Presentation of paper [131].

and educational activities based on the adaptive neuro-fuzzy input system (ANFIS), implemented in the package Fuzzy Logic Toolbox system MATLAB and artificial neural network direct propagation with one output and multiple inputs. As input variables of the system ANFIS used criteria for evaluating the educational program. The initial variable of the system formed a total indicator of the quality of the curriculum and educational activities according to a certain

criterion or group of criteria. The article considers a neural network that can provide a forecast for assessing the quality of educational programs and educational activities by experts. The training of the artificial neural network was carried out based on survey data of students and graduates of higher education institutions. Before the accreditation examination, students were offered questionnaires with a proposal to assess the quality of the educational program and educational activities of the specialty on an assessment scale covering four levels. Student assessments were used to form the vector of artificial neural network inputs. It was assumed that if the assessments of students and graduates are sorted by increasing the rating based on determining the average grade point average, the artificial neural network, which was taught based on this organized data set, can provide effective forecasts of accreditation examinations. As a result of comparing the initial data of the neural network with the estimates of experts, it was found that the neural network does make predictions quite close to reality.

This article highlights further research by the authors, begun in [128, 141, 149, 179, 187, 202, 218, 219, 221, 223, 224].

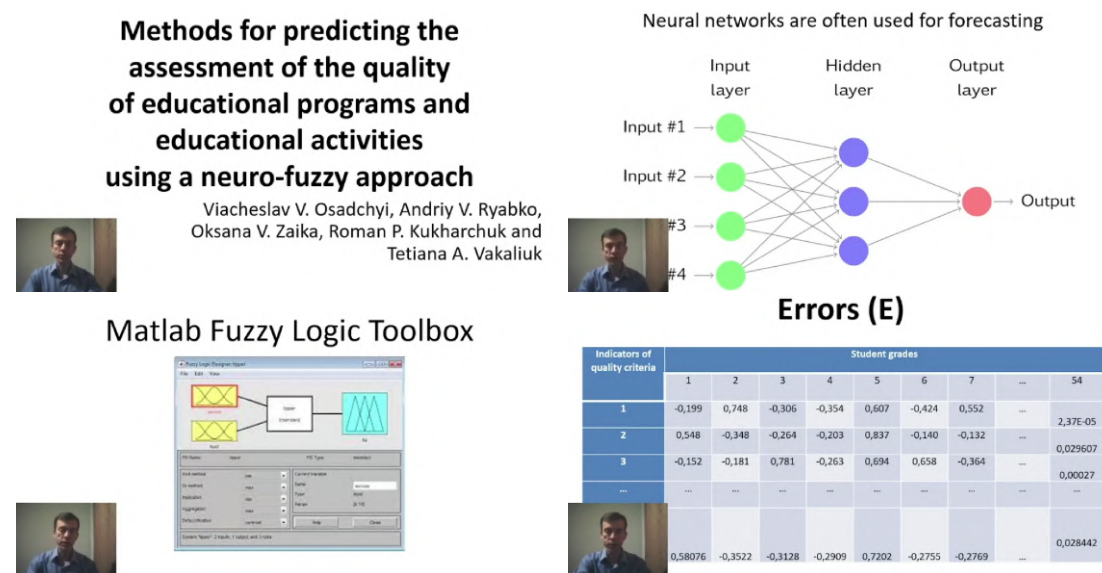


Figure 12: Presentation of paper [180].

Changes in society related to the development of science, technology, computing power, cloud services, artificial intelligence, increasing general access to huge amounts of open data, lead to increased global investment in technology and services. Appropriate training is required by specialists to create a workforce to work with artificial intelligence. On the one hand, it puts forward new requirements for the training of young people, and educational content, on the other hand, provides opportunities for the use of cloud technologies during the educational process. Widespread use of AI in various fields and everyday life poses the task of understanding the basic terms related to Artificial intelligence (AI), such as Machine learning (ML), Neural network (NN), Artificial neural networks (ANN), Deep Learning, Data Science, Big Data, mastering the basic skills of using and understanding the AI principles, which is possible during the study in

the school course of computer science. Cloud technologies allow to use the power of a remote server (open information systems, digital resources, software, etc.) regardless of the location of the consumer and provide ample opportunities for the study of artificial intelligence. In article “Cloud technologies for basics of artificial intelligence study in school” [225] Nataliia V. Valko, Tatiana L. Goncharenko, Nataliya O. Kushnir (figure 13) and Viacheslav V. Osadchyi reveal the possibilities of cloud technologies as a means of studying artificial intelligence at school, consider the need for three stages of training and provide development of tasks and own experience of using cloud technologies to study artificial intelligence on the example of DALL-E, Google QuickDraw, cloud technologies Makeblock, PictoBlox, Teachable Machine at different stages of AI study.

This article highlights further research by the authors, begun in [53, 54, 103, 136, 146–148, 151, 226, 228–230, 233, 252].

#### **2.4. Session 4: Cloud-based Learning Environments**

The article “UI/UX design of educational on-line courses” [240] by Kateryna V. Vlasenko, Iryna V. Lovianova, Sergii V. Volkov (figure 14), Iryna V. Sitak, Olena O. Chumak, Andrii V. Krasnoshchok, Nataliia G. Bohdanova and Serhiy O. Semerikov considers the problem of an interface for educational platform, which is fully effective for achieving the outcomes of educational activity. The current research is a theoretical analysis of existing recommendations on UI/UX design, applied when creating educational systems, as well as of research papers that study user interface (UI) usability and evaluate user experience (UX) in designing on-line platforms. This article describes a mechanism for evaluating usability with the help of baseline and final evaluation tool. It also studies UX components, that ensure its high quality. A list of standard components of web-design is being discussed in the present paper; modern trends in web-design of educational platforms are identified. The paper provides the description of an on-line course model, which is built on the basis of analysis of the prerequisites for existing and functioning of educational on-line systems and which is aimed at achieving outcomes of educational activity. There is ground to believe that the design of educational on-line courses will contribute to achieving the outcomes of educational activity, if user interface components comply with a list of criteria, such as easy-to-perceive content, no extra information, easy and simple navigation on the pages of the course, following the principles of usability.

This article highlights further research by the authors, begun in [1, 57, 109, 170, 189, 199, 206, 211, 241–244].

The world wide pandemic situation revealed the problems in all spheres of human life which haven't been faced before. Recently the world has changed greatly as well as the relationship between people and their professional activity. The great bunch of the workload, if basically acceptable, is done with the use of modern innovative technologies. Such problems have not trampled down the sphere of higher education as well. Distance learning, which was previously addressed to only as accompanying possibility of lessons conduct, nowadays is considered to be the only practicable form of conducting lectures, practical lessons, tests, i.e. it has become a usual daily practice for both teachers and students. Among the basic functional requirements to the electronic educational resources in the system of distance learning there are the visualization and interaction principles both when getting familiar with the theoretical material and when



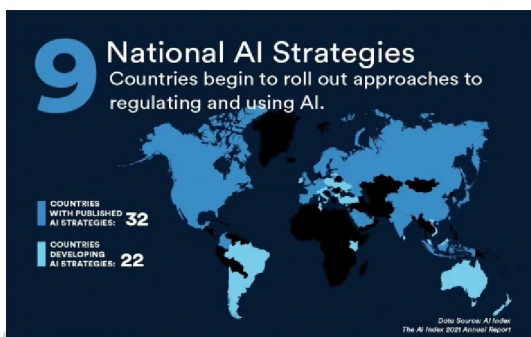
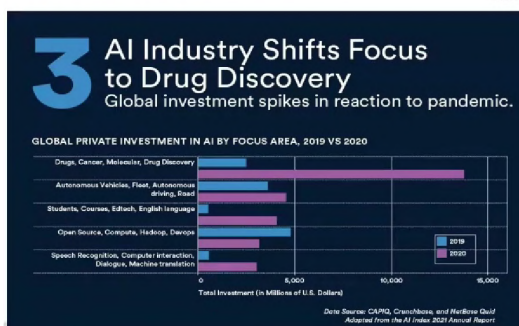
## Cloud Technologies for the Study of Artificial Intelligence in School

Natali Valko  
 Nataliya Kushnir  
 Tetiana Goncharenko  
 Viacheslav Osadchyi

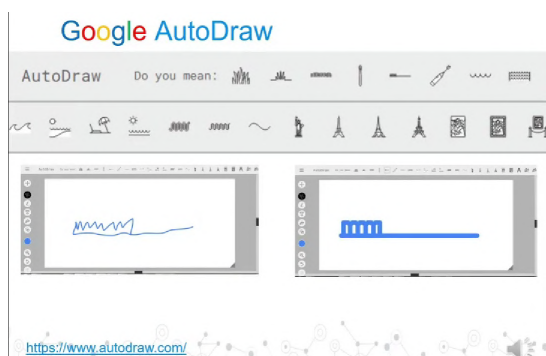
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[osadchyi@mdpu.org.ua](mailto:osadchyi@mdpu.org.ua)

Stanford HAI

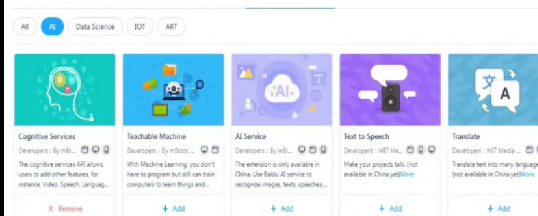
2021  
 Stanford HAI



Building your own machine learning programs in designers.



### Makeblock



Makeblock has five AI tools: mental services, machine learning, text-to-speech conversion, and translation.

Figure 13: Presentation of paper [225].

completing virtual laboratory and practical tasks. The Microsoft Office documents have become the most widespread elements among the electronic educational resources. That is why there is a pressing need in presenting the electronic MS Excel spreadsheets on the resource web-pages. The simple and convenient way to solve the problem of Excel documents introduction into the



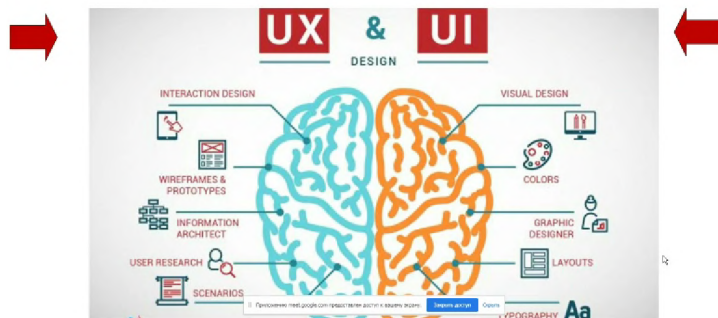
# UI/UX Design of Educational on-line Courses



Iryna Sitak, Kateryna Vlasenko, Iryna Lovianova, Sergii Volkov, Olena Chumak, Andrii Krasnoschok, Nataliia Bohdanova, Serhiy Semerikov

## UX | UI

ISO 9241-210:2019



The model  
developing  
on-line  
course

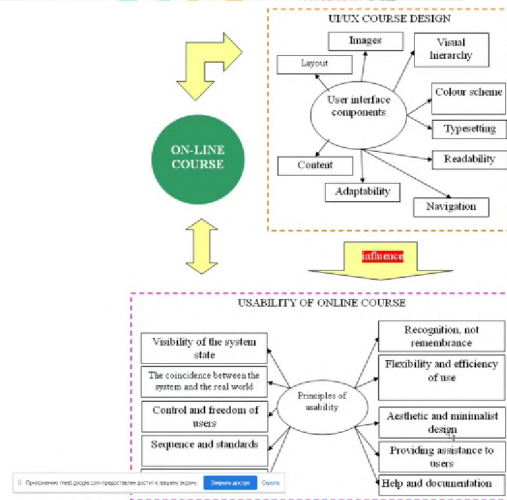
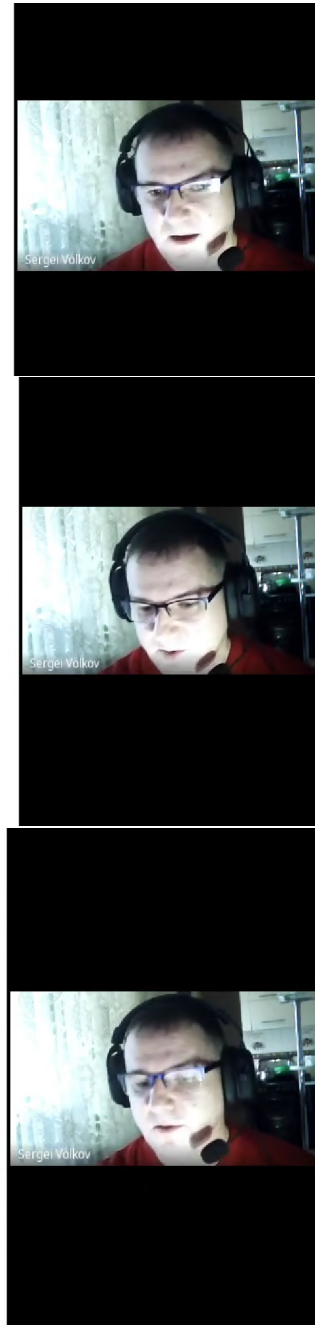


Figure 14: Presentation of paper [240].

electronic resources of the distance learning systems is the use of cloud services. The services help to acquire the access to the information resources of any level and of any capacity with the possibility to allocate the rights of the users belonging to different groups in relation to the



resources. For that purpose the availability of the Internet network access and web-browser would be enough. The cloud calculation technologies introduction allows for the use of the programs that do not require special licensing, update versions monitoring and eliminates the need of software technical support as the provider himself exercises control over the functioning, data saving, antivirus protection and possible cyberassaults. The peculiarities of professional training of navigators require the students to acquire the knowledge of professionally-oriented tasks algorithms as well as the knowledge of technologies that can help to implements them. One of the main routines the officer needs to deal with on the navigational bridge is the use of the information systems of shipboard hardware. But before usage he needs to assure of the systems reliability. That is why it is extremely important to gain during the course of professional training the necessary skills of navigation equipment exploitation reliability assessment by means of Microsoft Office documents and cloud services. So the subject matter of the article “The optimum assessment of the information systems of shipboard hardware reliability in cloud services” [97] by Lyudmyla V. Kravtsova, Tatyana V. Zaytseva, Oleh M. Bezbakh (figure 15), Hennadiy M. Kravtsov and Nataliia H. Kaminska is the procedure development for the navigation equipment exploitation reliability assessment by means of modern services use in the course of professional training of future seafarers. The aim of the paper is the solution of the problems of optimum assessment of the information systems of shipboard hardware reliability by means of cloud technologies usage. The following tasks are completed in the course of the research: the peculiarities and characteristics of navigational information processed by the shipboard navigation and information system have been analyzed; the results of the information systems of shipboard hardware usage have been studied; the technological diagram of the basic components structuring of the “Information systems of shipboard hardware” complex for the Master’s degree training course has been created; the effective technology of the program Excel documents processing has been chosen; the system of access and usage of web-services for calculation tables processing in the system of distance learning has been designed; the process of competency formation which will enable students to use cloud services has been suggested.

This article highlights further research by the authors, begun in [40, 95, 96, 98, 126, 178, 185, 194, 254].

## **2.5. Session 5: Cloud-based E-learning Platforms, Tools and Services**

The article “Selecting cloud computing software for a virtual online laboratory supporting the Operating Systems course” [61] by Olena S. Holovnia and Vasyl P. Oleksiuk (figure 16) provides a survey on cloud platforms suitable for a virtual online laboratory, which contains Linux online environments and is intended to support the Operating Systems course. The study justifies the choice of utilizing private cloud as a deployment model and IaaS as a service model and substantiates the decision to create specially tailored cloud environments adapted for educational needs in contrast to applying ready-made IaaS (Infrastructure as a Service) cloud services given by providers. The related works on cloud platforms for teaching operating systems are analyzed. The study also makes a review of the authors’ previous research on virtualization tools and environments for the Operating Systems course and Cisco CyberSecurity Operations course. The basic and additional requirements for cloud computing software for virtual online laboratory supporting Operating Systems course have been elaborated. Finally,



Kherson State Maritime Academy  
 Department of Department of Innovative Technologies  
 and Technical Devices of Navigation

# The Optimum Assessment of the Information Systems of Shipboard Hardware Reliability in Cloud Services

Authors: Lyudmila Kravtsova, Tatyana Zaytseva, Oleh Bezbakh, Hannady Kravtsov, Natalia Kaminska  
 Speaker: Oleh Bezbakh

Kherson—2021

## The mathematical model

the basic reliability law:

If  $\lambda(t) = \lambda = const$ , then  $P(t) = e^{-\lambda t}$  and  $a(t) = \lambda e^{-\lambda t}$ ,

$$a(t) = -\frac{dP(t)}{dt} \quad (3)$$

where  $P(t)$  - is the probability of trouble-free operation of the object;  
 $a(t)$  - is the frequency of failures or the frequency time distribution of trouble-free operation.

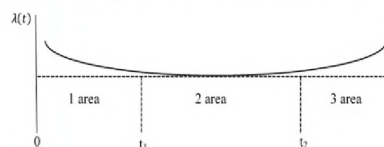


Fig. 1.  $\lambda$ - technical system's characteristic

## Shipboard automated system structural diagram

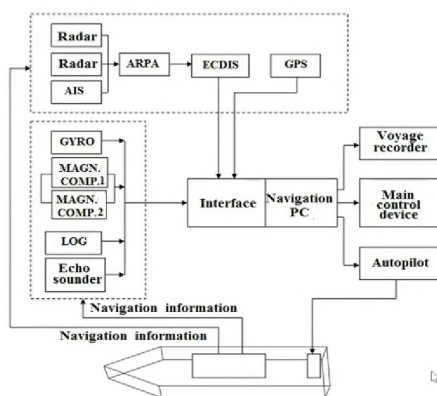
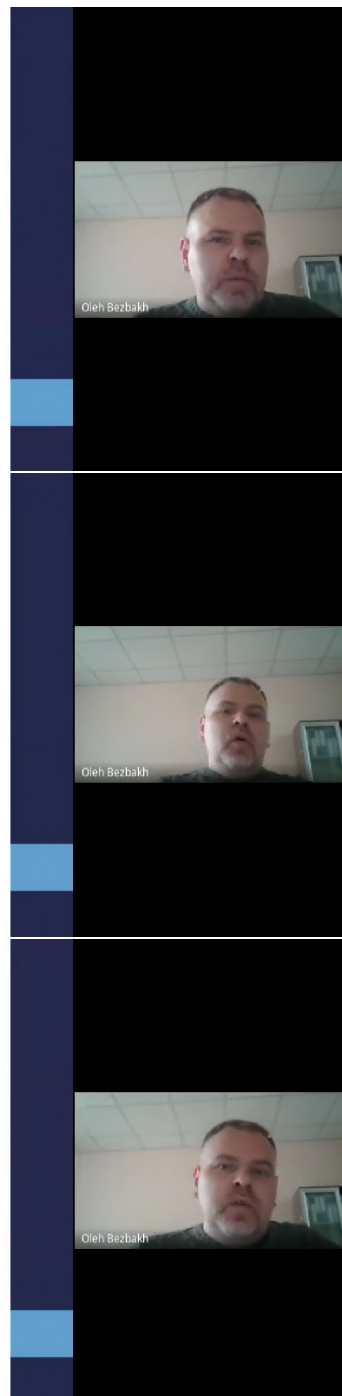


Figure 15: Presentation of paper [97].

the work makes the comparison of Eucalyptus, OpenStack, CloudStack and OpenNebula cloud



platforms and substantiates the selection among these cloud computing software the platforms of the first and the second choice.

This article highlights further research by the authors, begun in [6, 7, 60, 142, 143, 145].



Figure 16: Presentation of paper [61].

The article “Hardware and software tools for teaching the basics of quantum informatics to students of specialized (high) schools” [106] by Liudmyla V. Lehka (figure 17), Svitlana V. Shokaliuk, Viacheslav V. Osadchyi defines the criteria for choosing a cloud-based platform for mastering the basics of quantum informatics by students of a specialized (high) schools: cross-browser; intuitive interface; the possibility of free access; access without registration and simplified registration; the presence of a systematized reference system with examples; support for the development of the environment by the developer; support for working in a personal educational environment; support for working with quantum algorithms in graphical mode; automatic conversion of quantum algorithms from graphic format to program code text; support for the Ukrainian-language localization; availability of a mobile application; responsive design. The possibilities of platforms for implementing quantum algorithms from the following companies are analyzed: Microsoft, QuTech, Amazon Braket, IBM. The choice of the IBM Quantum cloud-based platform is justified. Work at IBM Quantum Composer and



IBM Quantum Lab is described. Information about quantum operations and gates is presented: their designation in IBM Quantum Composer and IBM Quantum Lab, the gate matrix, and the purpose of the gate. An example of implementing quantum teleportation in the form of a circuit and program is given.

This article highlights further research by the authors, begun in [104, 105, 124, 127, 150, 193, 204, 205, 215, 227].

Liudmyla V. Lehka, Svitlana V. Shokaliuk, Viacheslav V. Osadchyi

## HARDWARE AND SOFTWARE TOOLS FOR TEACHING THE BASICS OF QUANTUM INFORMATICS TO STUDENTS OF SPECIALIZED (HIGH) SCHOOLS

17.12.2021

### EXPERT SURVEY

#### 1. Фізичні основи квантових технологій

Оцініть важливість наступних ЗНАНЬ для формування компетентності з фізичних основ квантових технологій

#### 2. Математичні основи квантової інформатики

Оцініть важливість наступних ЗНАНЬ для формування компетентності з математичних основ квантової інформатики

Hardware and software tools for teaching the basics of quantum informatics to students of specialized

### SURVEY AMONG COMPUTER SCIENCE TEACHERS

#### Course "Basics of quantum computer science"

■ expressed the opinion that they would like to personally take the course: "fundamentals of quantum computer science"  
■ Yes, but not now.

#### Course "Basics of quantum computer science"

■ would offer a course "fundamentals of quantum computer science"  
■ refused because, in their opinion, this course will not correspond to the profile of the educational institution where they work  
■ No

Hardware and software tools for teaching the basics of quantum informatics to students of specialized

Figure 17: Presentation of paper [106].

The article “Using the Yammer cloud service to organize project-based learning methods” [27] by Dmytro M. Bodnenko (figure 18), Halyna A. Kuchakovska, Oleksandra V. Lokaziuk, Volodymyr V. Proshkin, Svitlana H. Lytvynova and Olha H. Naboka reveals and interprets the key features of project-based learning based on cloud-based services: social activity; convenient communication in a team during the project implementation and at the resulting stage; open educational space; self-learning and self-improvement; use of interdisciplinary links to combine students of different years of study (1–4 degrees of the first (bachelor’s) level and students of the second master’s level) to joint research teams to study through research; purposeful motivation of cognitive and research activity of students within the discipline with the use of interdisciplinary connections; formation of digital literacy of students. The advantages and disadvantages of the Yammer cloud service are presented and a comparative analysis of this service with similar cloud services is performed. Examples of using Yammer in professional project activity are given. The stages of using project methods using the small group method are analyzed and detailed: initiation; planning; conducting/implementation; presentation; assessment/defense.

This article highlights further research by the authors, begun in [5, 28, 30, 38, 58, 59, 75, 114, 175, 176, 186, 212].

The article “The didactic potential of cloud technologies in professional training of future teachers of Ukrainian language and literature” [169] by Olha B. Petrovych (figure 19), Alla P. Vinichuk, Oksana A. Poida, Viktoriia I. Tkachenko, Tetiana A. Vakaliuk and Olena H. Kuzminska deals with the peculiarities of the usage cloud technologies for the organization of students-philologists’ individual and group work in studying the discipline “Scientific Research Basics”. The relevance of the introduction of cloud technologies for formation the readiness of the future teachers of Ukrainian language and literature to the professional activity is substantiated. Analysis of the scientific sources suggested that the quality of professional training process of future teachers-philologists has reached a new level by the means of cloud technologies. The domestic and foreign experience of cloud technologies implementation into current educational practices is generalized. The features of blended learning organization for professional training students-philologists at the Mykhailo Stelmakh Faculty of Philology and Journalism of Vinnytsia Mykhailo Kotsiubynskyi State Pedagogical University during the studying the discipline “Scientific Research Basics” by using cloud technologies are described. The practical aspects and experience of preparation the future teachers of Ukrainian language and literature to a fluent usage of innovative cloud-based means are detailed. It is specified that the educational process is based on the communication by Gmail, Viber and Telegram messengers, store on Google Drive resource, work with educational video on YouTube, conducting online classes in Google Meet, creation publication in any of the social networks (Facebook, Instagram, TikTok), formation the different styles of references design on The Cite This for Me resource, conducting literature search on various search engines, namely Google Scholar, ScienceDirect, Web of Science, creating multimedia presentation at Prezi or Canva, making MindMaps on Mindomo, infographics on interactive board Google Jamboard or Padlet, on services for graphic design Canva and Visme, etc. Prospects for experimental studying the effectiveness of using cloud technologies in learning discipline “Scientific Research Basics” are determined.

This article highlights further research by the authors, begun in [3, 25, 48, 123, 168, 174, 181, 203, 216, 222, 231].

9th Workshop on Cloud Technologies in Education  
Kryvyi Rih, Ukraine, Dec 17, 2021

**Using the Yammer cloud service to organize project-based learning methods**

Svitlana H. Lytvynova, Dmyto M. Bodnenko, Halyna A. Kuchakovska, Oleksandra V. Lokaziuk, Volodymyr V. Proshkin, Olha H. Naboka

## Project-based learning or project-based learning technologies

### The effectiveness of implementing project teaching methods using cloud services

Response	Count	Percentage
Yes	4	16%
Rather yes	4	16%
Rather no	11	44%
No	6	24%

Fig. 2

### Has an idea in the implementation of project methods?

Response	Count	Percentage
Yes	2	9%
Rather yes	6	26%
Rather no	8	35%
No	7	30%

Fig. 1

Figure 18: Presentation of paper [27].



Figure 19: Presentation of paper [169].

Practical training is an integral part of the professional training of future teachers. During the practical training, trainees not only implement their own theoretical training in practice, but also increase the level of information competence. The rapid use of e-learning resources for distance learning during epidemiological constraints caused by biological threats poses new challenges to education in the availability of e-learning resources. The development of electronic educational resources is a difficult task, one of the ways to solve it is to involve future teachers in this process during the initial practice. In the article “Creation of open educational resources during educational practice by means of cloud technologies” [234] by Vladyslav Ye. Velychko (figure 20), Elena G. Fedorenko, Vladimir N. Soloviev and Ludmila V. Dolins’ka, the experiment of creating open educational resources by means of cloud technologies during the training practice showed the probability of solving this problem. Restrictions in direct contact between participants in the experiment, both due to epidemiological restrictions and through practical training in various educational institutions, are solved through the use of cloud technologies. The latter provides an opportunity to easily disseminate developed open educational resources and disseminate best practices in creating educational content.

This article highlights further research by the authors, begun in [36, 45, 46, 73, 182, 196, 210, 236].

The system for remote assessment of knowledge automates formation of task (tickets) with questions and tasks for conducting intermediate and final monitoring of knowledge of students is offered by Mykhailo I. Sherman, Yaroslava B. Samchynska (figure 21) and Vitaliy M. Kobets in the article “Development of an electronic system for remote assessment of students’ knowledge in cloud-based learning environment” [188]. In the process of developing an electronic system for knowledge assessment, the basic requirements for a web application and the modules





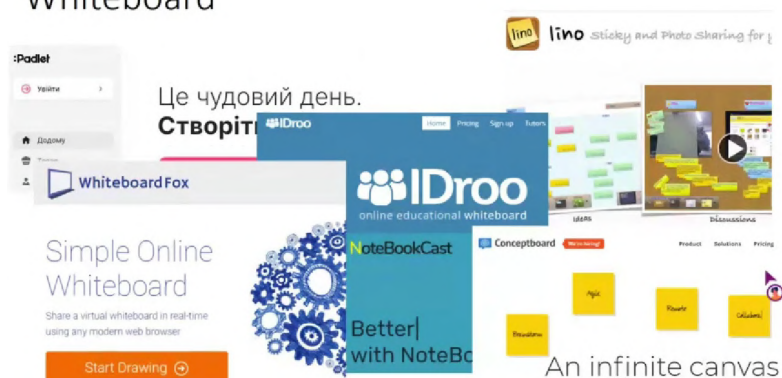
## Creation of open educational resources during educational practice by means of cloud technologies

Vladyslav Ye. Velychko, Elena G. Fedorenko, Vladimir N. Soloviev and Ludmila V. Dolins'ka

17/12/2021



### Whiteboard



### The results of a survey of students on the means of creating infographic



Figure 20: Presentation of paper [234].

that the system consists of were determined, the main roles of users in the system and their functionality were identified, access rights were established. The technical, functional, and non-functional features of the software product are described, web technologies for creating an

application for knowledge assessment are considered. The diagram of system sequences, the use-case diagram, which schematically describing roles and functions of agents in an information system, the diagram of classes of a database structure are presented with UML description. Based on the defined requirements for the resource in cloud-based learning environment, the following technologies for its development were chosen: the server programming language PHP, JavaScript programming language and its libraries were used, as well as the MySQL database with PhpMyAdmin tool for administration of chosen database management system. OpenServer software complex system was used to develop and test the application functionality. The usage of the proposed electronic assessment system of knowledge contributes to the formation of an open information and cloud-based learning environment of a modern educational institution, enhances the efficiency and more rational distribution of teacher time in preparing tests or exams, activates repetition of educational material and knowledge assimilation, indirectly motivates students to more honest learning.

This article highlights further research by the authors, begun in [72, 88–91].

## **2.6. Session 6: Immersive Technology Applications in Education**

The article “The use of specialized software for liquid radioactive material spills simulation to teach students and postgraduate students” [172] by Oleksandr O. Popov, Yurii O. Kyrylenko, Iryna P. Kameneva, Anna V. Iatsyshyn, Andrii V. Iatsyshyn, Valeriia O. Kovach (figure 22), Volodymyr O. Artemchuk, Valery N. Bliznyuk and Arnold E. Kiv proves relevance of specialized software use to solve problems of emergencies prevention of radioactive liquids spills to teach students and graduate students. Main assessment criteria of accidents at radiation-hazardous objects associated with radioactive liquids spillage is identified. A model of radioactive substances transport in emergency rooms is developed. It takes into account physical features of radioactive liquid spill from the source, air pollution during transition of radioactive liquid from the spill surface into the air and subsequent scattering in the emergency room under influence of local air flows. It is determined that the existing software tools for radiation exposure assessment do not comprehensively cover features of such events and possess number of shortcomings regarding accidents modeling with spillage of radioactive liquids indoors. Computer modeling and forecasting examples for hypothetical event related to liquid radioactive spill in the JRODOS system are presented. The training process of future specialists, specialties 183 “Environmental Protection Technologies”, 143 “Nuclear Energy”, 103 “Earth Sciences”, and 122 “Computer Science” should be based on application of powerful scientific and methodological training base using modern achievements in the field of digital technologies. It is advisable to supplement curricula for students’ and postgraduate students’ preparation in the mentioned above specialties by studying issues related to: development of mathematical models and software for solving problems of emergencies prevention in case of radioactive liquids spills; usage of features of specialized decision software of emergencies prevention during spills of radioactive liquids.

This article highlights further research by the authors, begun in [56, 62–65, 67, 68, 71, 76, 102, 107, 125, 171, 201, 250, 255, 256].

The article [11] by Ilona V. Batsurovska, Nataliia A. Dotsenko (figure 23), Vladimir N. Soloviev, Svitlana H. Lytvynova, Olena A. Gorbenko, Nataliia I. Kim and Antonina P. Haleeva presents the technology of application of 3D models of electrical engineering in the performing laboratory

CTE 2021

## Development of an electronic system for remote assessment of students' knowledge in cloud-based learning environment

Mykhailo Sherman  
Yaroslava Samchynska  
and Vitaliy Kobets

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kobetz@ukr.net

### Establishing roles and their functions in the assessment system

- ❖ Within the developed e-assessment system, three roles were defined: system administrator, teacher and student.
- ❖ The roles of the system and their functions are shown in the form of a use-case UML diagram in Figure 3.

CTE 2021      7      **Fig. 3.** Users roles within e-assessment system and their functions

Figure 21: Presentation of paper [188].

work. It was outlined the organizational and methodological conditions, forms and methods, learning tools of the proposed technology. The organizational and methodological conditions include the use of computer 3D models in laboratory work; creation and implementation into the educational process laboratory work that involves the development of computer 3D modeling; providing the necessary guidelines for the use and development of computer 3D modeling during laboratory work. Application of the 3D models in the performing laboratory work of electrical engineering disciplines can be realised on the initial, average and high levels. Upon completion of the development of the presented technology, an experimental study was conducted, which included the identification of the appropriate level of use of 3D models in the process of performing laboratory work in the study of electrical engineering disciplines. The obtained experimental results were verified using Student's statistical t-test for relative indicators. The result of the implementation of technology is the application of 3D models in educational and professional activities in the field of electrical engineering.

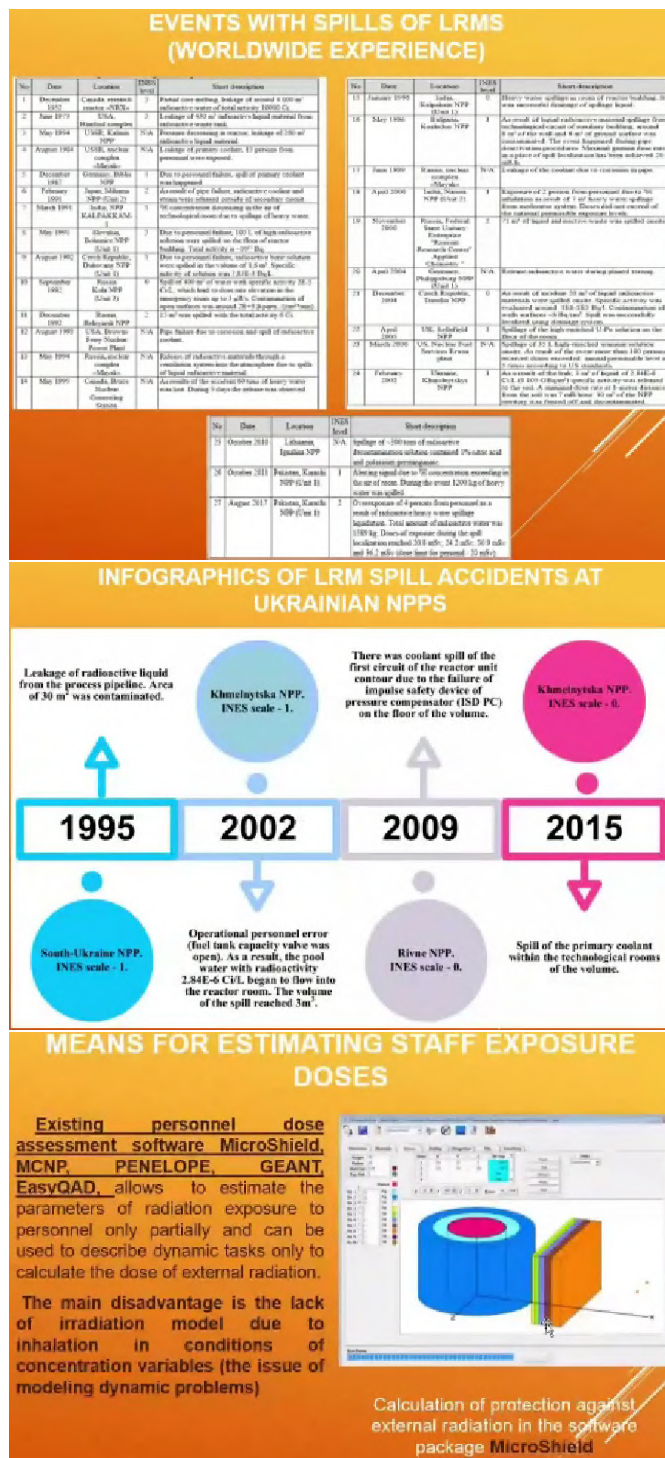


Figure 22: Presentation of paper [172].



This article highlights further research by the authors, begun in [9, 10, 16, 19, 37, 83, 184, 214, 253].

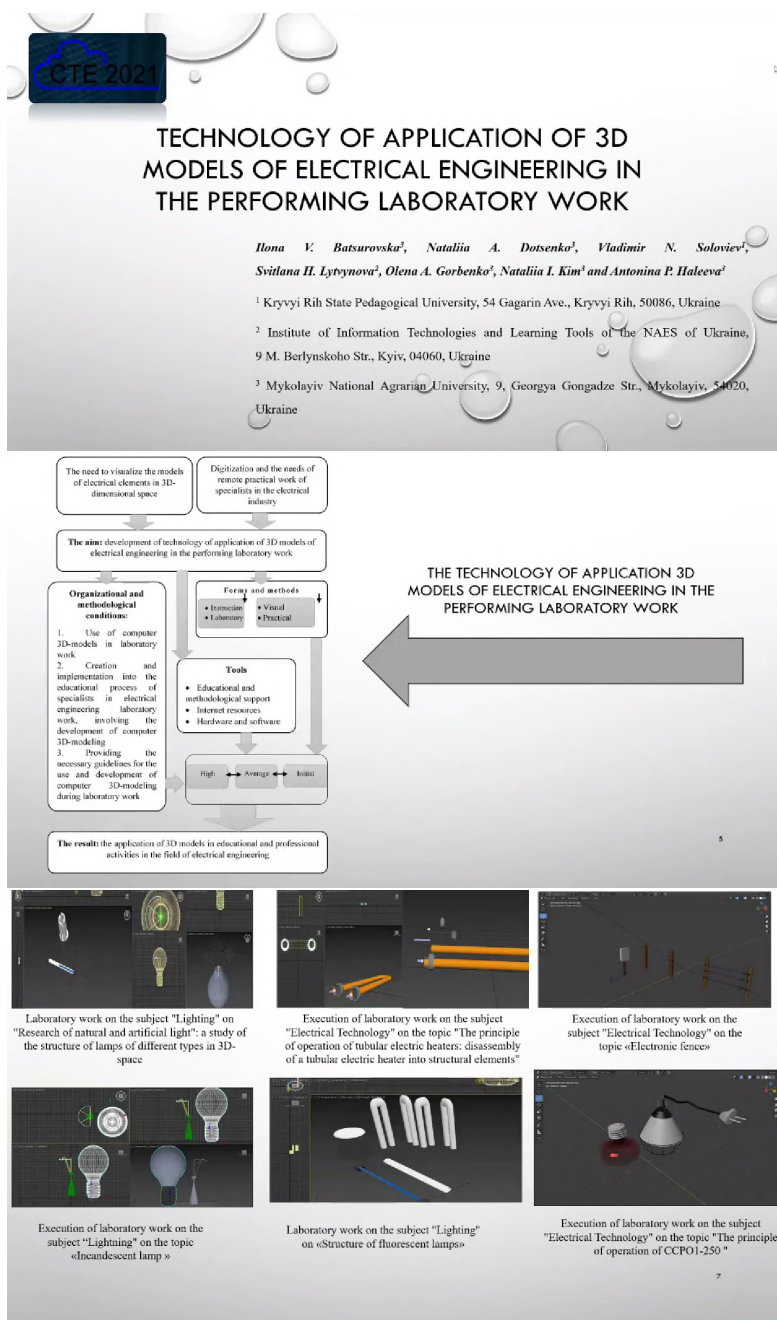


Figure 23: Presentation of paper [11].

The article “Immersive learning technology for ensuring quality education: Ukrainian university case” [108] by Volodymyr O. Liubchak, Yurii O. Zuban and Artem E. Artyukhov (figure 24)

considers the problem of using immersive learning in the educational and scientific activities of the university. Literature survey revealed that there is a need for an integrated approach for introduction of immersive learning at the university. It involves the creation of a specialized laboratory of virtual and augmented reality with appropriate technical equipment, introduction of immersive learning methodology in university educational programs, development of software and hardware solutions for immersive learning, and research on the immersive learning effectiveness. Authors present the description of a specialized university department acting as a developer of software products for immersive learning. Authors show original developments in the field of immersive education for exact sciences and arts and humanities students. The article describes products that are designed to fulfill the third university mission: to ensure the citizens well-being. Authors propose "immersive institute" model which can be implemented both at the level of the university in general and at the level of its educational and scientific departments.

Being popular world-wide, virtual laboratories enter into different fields of education and research and practitioners have to be responsible for choosing the most suitable and then adapt them to particular field. The aim of the article "Enhancing digital and professional competences via implementation of virtual laboratories for future physical therapists and rehabilitologist" [42] by Halina I. Falfushynska (figure 25), Bogdan B. Buyak, Grygoriy M. Torbin, Grygorii V. Tereshchuk, Mykhailo M. Kasianchuk and Mikołaj Karpiński was to assess the effectivity of the implementation of Praxilab, Labster, and LabXchange virtual laboratories as the powerful digital tool into teaching protocols of "Clinical and laboratory diagnostics" discipline for physical therapists and rehabilitologist. Authors have carried out the online survey for 45 students enrolled in physical rehabilitation degree program. About 70% surveyed students reported that implementation of virtual laboratories in "Clinical and laboratory diagnostics" discipline met individual learning needs of students, helped acquired digital skills (25%), and supported them to stay ahead of the curve. The virtual lab applications, not only assisted harness students fair against lack of practical skills, but also brought about a new dimension to the classes and helped overcome digital alienation and gain their digital skills and abilities. Indeed, a virtual lab can't completely replace the experimental work and teacher's explanation, but it might support teaching activities of a modern mentor and learning activities of a modern student. Almost all of surveyed students (82%) expected that in near future the virtual laboratories would take the dominant place in the education market due to possibility of students' pre-train the key points of practical activities before real experiments in lab and better understand their theoretical backgrounds. Thus, this study is intended to contribute to utilization of virtual labs by students enrolled in study physical therapy/physical rehabilitation with expected efficiency.

This article highlights further research by the authors, begun in [31, 32, 34, 41, 200, 207–209, 213, 249].

Nowadays simulation training technology is a priority method of maritime specialists' practical training in the world. The main purpose of using VR simulators within an educational process is to simulate work on real equipment in order to form professional competencies of seafarers. The article "Formation of professional competency in life saving appliances operation of future seafarers by means of online and simulation VR technologies" [246] by Serhii A. Voloshynov, Halyna V. Popova, Olena S. Dyagileva, Nataliya N. Bobrysheva and Olha V. Fedorova (figure 26) describes system of blended learning on the basis of Kherson State Maritime Academy, that



## Immersive Learning Technology for Ensuring Quality Education: Ukrainian University Case

Volodymyr Liubchak  
Yurii Zuban  
Artem Artyukhov

Sumy State University, Sumy, Ukraine

December 17, 2021, Kryvyi Rih, Ukraine

### SumDU cases



Natural gas drying unit simulator



Virtual tour around the Military Training Department



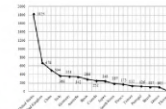
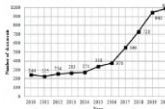
Full body tracking technology application



6

<https://pezi.com/3jntw/065bcx/university-online-learning-ecosystem/>

### Literature Review



The results of bibliometric analysis on the query "immersive technology education" (VOSViewer tool, data from <https://www.scopus.com/>)

### Conclusions: human resources



## Conclusions: "Immersive institute" model

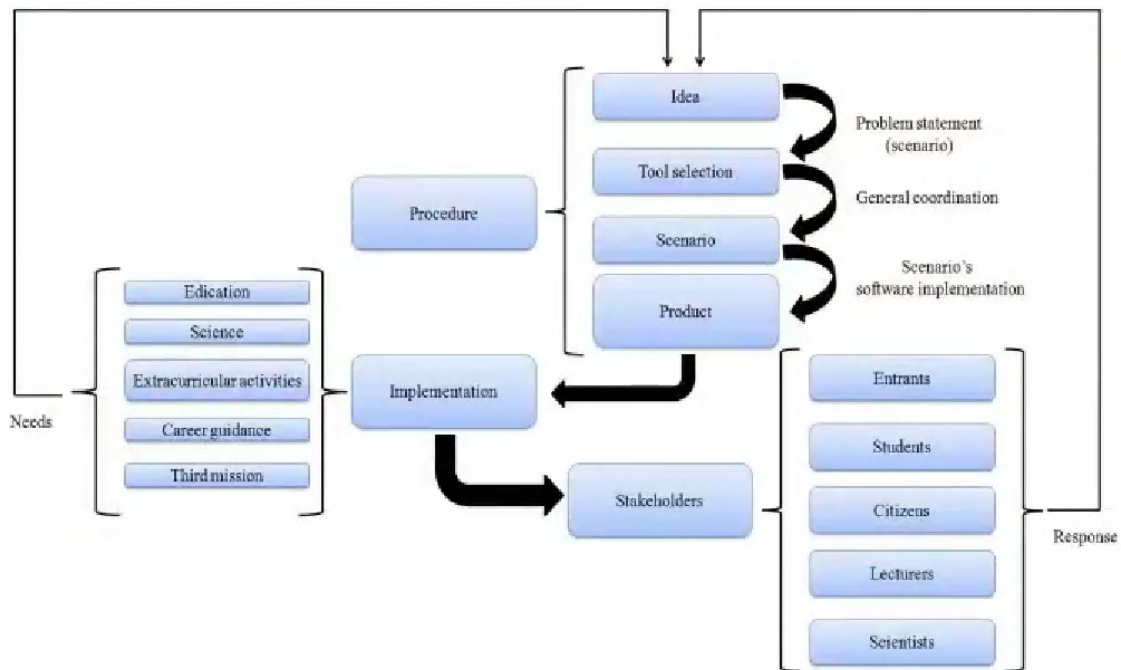


Figure 24: Presentation of paper [108].

includes alternation of traditional and online learning, virtual training by means of the VR

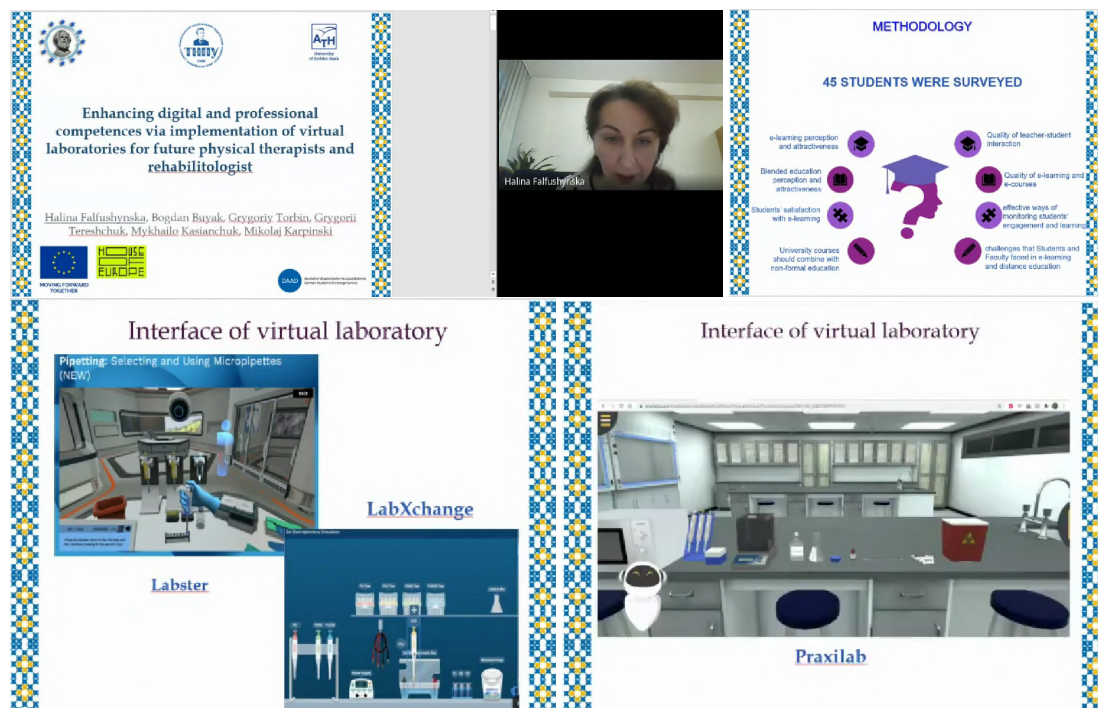


Figure 25: Presentation of paper [42].

technology, training on simulators. In accordance with the principles of blended learning in Academy, there was developed an author’s course “Rescue boats and life rafts specialist”, which aims at providing theoretical and practical training of seafarers on launching and handling the lifeboats and liferafts and, as a result, ensures seafarers’ formation of professional competency “life-saving appliances operation”. The article also reveals the results of an experiment with implementation of VR technologies in forming the professional competency “life-saving appliances operation”. The deviation of the results in control and experimental groups was 9,8%. The effectiveness of the research was manifested in the fact that students have gained experience of practical skills before coming to the vessel and showed higher level of educational achievements in professional competency “life-saving appliances operation”.

This article highlights further research by the authors, begun in [39, 111, 247, 248].

The article “Clouds of words as a didactic tool in literary education of primary school children” [139] by Liudmyla L. Nezhyva (figure 27), Svitlana P. Palamar, Maiia V. Marienko reveals the possibilities of using the words’ cloud in the literary education of primary school children. The authors consider the possibility of using a cloud of words to visualize the keywords of the text for the translation of the work of art, the interpretation of the main idea and the characteristics of the artistic image. The words’ cloud can also be used as a reference summary to answer questions about the content of the work or to present the results of a school project by students. Moreover, in reading lessons, this tool can be used as a tool to identify the topic of the lesson. The study reveals the possibilities of the didactic tool of the words’ cloud for the development of speech of primary school children, in particular, in composing their own





Figure 26: Presentation of paper [246].

texts and editing them, the ability to explore words that the student uses too often and avoid tautology. Using the method of a problem situation and visually demonstrating information through a cloud of words, the teacher pro-motes the activation of students' mental activity, the development of creative abilities and critical thinking. The study tested the use of the electronic resource WordArt in primary school – a website for creating a “word’s cloud” and proved its effectiveness in reflection, as well as creating an image of the main idea of the lesson, general conversation, its use as didactic material. The authors used the technology of learning using a cloud office package Google Drive to write a draft of their own statement of primary school

**CTE 2021**

**CLOUDS OF WORDS AS A DIDACTIC TOOL IN LITERARY EDUCATION OF PRIMARY SCHOOL CHILDREN**

Authors:  
Liudmyla Nezhyva,  
Svitlana Palamar,  
Maia Marienko

1) TO ANALYZE SCIENTIFIC SOURCES ON THE PROBLEM OF USING THE WORD CLOUD IN EDUCATION

**Literature review**

- N. Franchuk, Lytvynova S. characterized the features of the cloud-based learning environment
- A. Damnikaya considered in its study cloud-based platforms, tools and services
- M. Sheina has developed guidelines for the use of SMART boards in primary school lessons
- S. Ram., L. Blousova and N. Zhylyanova consider cloud services as an effective visualization tool
- R. Makhachashvili, S. Kovplik, A. Bakhtina, E. Shmeltser consider the technology of visualizing the text of poetry using emolicon symbols on the Emoji Maker platform

Teachers' forums actively discuss the use of cloud technologies in the classroom, which indicates the urgency of the problem and its practical significance

Cloud Technologies in Education – CTE 2021

**WITHIN THE FRAMEWORK OF THIS PROBLEM, A STUDY WAS CONDUCTED TO STUDY THE POSSIBILITY OF USING THE "WORD CLOUD" AS A MEANS OF ACTIVATING THE ANALYTICAL THINKING OF YOUNGER STUDENTS IN THE PROCESS OF READING**

Clouds of words based on the works of Zirka Menzatyuk

Clouds of words based on the works of Lesya Voronina

Cloud Technologies in Education – CTE 2021

Figure 27: Presentation of paper [139].

children. The authors investigated the use of the service in the lesson of literary reading during the organization of reading activities in the following areas: in the “cloud of words” to encrypt

the topic of the lesson; using the cloud as visual material or as basic information to explain new material; encrypt certain words from the text in the cloud, students' task to guess the work; create a cloud of words of positive and negative characters of the work; write a story on the topic; create an "encrypted postcard" to the writer or hero of the work. In the course of experimental work, the effectiveness of the use of this didactic tool in the lessons of literary reading in primary school during the analysis of texts in order to identify the most important associations of students was confirmed.

This article highlights further research by the authors, begun in [118–120, 138, 140, 158, 190, 191].

### 3. Conclusion

9th Workshop on Cloud Technologies in Education (CTE 2021) was organized by Kryvyi Rih National University (with support of the rector Mykola I. Stupnik) in collaboration with Kryvyi Rih State Pedagogical University (with support of the rector Yaroslav V. Shramko), Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine (with support of the director Valeriy Yu. Bykov) and University of Educational Management (with support of the vice-rector for research and digitalization Oleg M. Spirin).

Authors are thankful to all the authors who submitted papers and the delegates for their participation and their interest in CTE 2021 as a platform to share their ideas and innovation. Also, authors are also thankful to all the program committee members for providing continuous guidance and efforts taken by peer reviewers contributed to improve the quality of papers provided constructive critical comments, improvements and corrections to the authors are gratefully appreciated for their contribution to the success of the workshop.

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