

ACNS Conference on Cloud and Immersive Technologies in Education: Report

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Abstract. This article serves as an introduction to a collection of selected papers presented at the ACNS Conference on Cloud and Immersive Technologies in Education (CITED 2022), which took place in Kyiv, Ukraine, on December 21-22, 2022. The collection provides valuable insights into the latest advancements in cloud and immersive technologies in the field of education. The introductory text offers an overview of the conference events and provides concise summaries of the selected papers, offering a glimpse into the diverse topics and research areas covered. These selected papers reflect the cutting-edge research and innovative approaches showcased at CITED 2022, making them a valuable resource for educators, researchers, and practitioners interested in exploring the potential of cloud and immersive technologies in education.

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, design and implementation of immersive learning environments, digital transformation of education, educational data mining, emotion AI, immersive technologies in professional training and retraining, immersive technologies in science education, immersive technology applications in education, mobile learning, smart campus technologies, social analytics in education, virtualization of learning: principles, technologies, tools, VR/AR gamification

1. Introduction

1.1. CITED 2022 at a glance

ACNS Conference on Cloud and Immersive Technologies in Education (CITED) is a peer-reviewed international conference focusing on research advances, applications of cloud and immersive technologies in education.

CTE+AREdu=CITED is a collaborative effort between two flagship ACNS workshops, *Cloud Technologies in Education* (since 2012) and *Augmented Reality in Education* (since 2018).

CITED topics of interest:

- 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



Figure 1: CITED 2022 logo.

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- Design and Implementation of Immersive Learning Environments
- Digital Transformation of Education
- Educational Data Mining
- Emotion AI
- Immersive Technologies in Professional Training and Retraining
- Immersive Technologies in Science Education
- Immersive Technology Applications in Education
- Mobile Learning
- Smart Campus Technologies
- Social Analytics in Education
- Virtualization of Learning: Principles, Technologies, Tools
- VR/AR Gamification

This volume represents the proceedings of the ACNS Conference on Cloud and Immersive Technologies in Education (CITED 2022), held in Kyiv, Ukraine, on December 21-22, 2022. It comprises 24 contributed papers that were carefully peer-reviewed and selected from 36 submissions. Each submission was reviewed by at least 3 program committee members. The accepted papers present the state-of-the-art overview of successful cases and provides guidelines for future research.

1.2. CITED 2022 committees

1.2.1. Program committee

- *Marc Baaden*, CNRS, France [14]
- *Pablo Garcia Bringas*, University of Deusto, Spain [89]
- *Oleksandr Burov*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine & University of Vienna, Austria [27]
- *Nadire Cavus*, Near East University, North Cyprus [137]
- *El-Sayed El-Horbaty*, Ain Shams University, Egypt [88]
- *Ramón Fabregat*, University of Girona, Spain [35]
- *Irina Georgescu*, Bucharest University of Economics, Romania [43]
- *Mustansar Ali Ghazanfar*, University of East London, United Kingdom [58]
- *Anita Goel*, University of Delhi, India [16]
- *Carina Gonzalez*, Universidad de La Laguna, Spain [45]
- *Sven Hartmann*, Clausthal University of Technology, Germany [150]
- *Michail Kalogiannakis*, University of Crete, Greece [52]
- *Yuriy Kondratenko*, Petro Mohyla Black Sea State University, Ukraine [69]
- *Francesco Lelli*, Tilburg University, Netherlands [40]
- *Chung-Sheng Li*, PwC, United States [32]

- *Piotr Lipiński*, Technical University of Lodz, Poland [93]
- *Jinwei Liu*, Florida A&M University, United States [80]
- *Alessandra Lumini*, University of Bologna, Italy [101]
- *Rashid Mehmood*, King Abdulaziz University, Saudi Arabia [90]
- *Vincenzo Moscato*, University of Naples “Federico II”, Italia [98]
- *Thomas Moser*, St. Pölten University of Applied Sciences, Austria [26]
- *Ranesh Kumar Naha*, University of Tasmania, Australia [100]
- *Stamatios Papadakis*, University of Crete, Greece [79]
- *Michael M. Resch*, HLRS, University of Stuttgart, Germany [76]
- *Nina Rizun*, Gdańsk University of Technology, Poland [149]
- *Abdel-Badeeh M. Salem*, Ain Shams University, Egypt [15]
- *Demetrios Sampson*, University of Piraeus, Greece [111]
- *Antonio Sarasa Cabezuelo*, Universidad Complutense de Madrid, Spain [29]
- *Prem Kumar Singh*, Gandhi Institute of Technology and Management, India [132]
- *Daniel Thalmann*, Swiss Federal Institute of Technology in Lausanne, Switzerland [87]
- *Longkai Wu*, National Institute of Education, Singapore [31]
- *Eftim Zdravevski*, University Ss Cyril and Methodius, Macedonia [51]

1.2.2. Organizing committee

- *Hennadiy Kravtsov*, Kherson State University, Ukraine [75]
- *Maiia Marienko*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine [119]
- *Iryna Mintii*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine [91]
- *Viacheslav Osadchyi*, Borys Grinchenko Kyiv University, Ukraine [129]
- *Olha Pinchuk*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine [28]
- *Serhiy Semerikov*, Kryvyi Rih State Pedagogical University, Ukraine [92]
- *Mariya Shyshkina*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine [126]
- *Oleksandra Sokolyuk*, Institute for Digitalisation of Education of the NAES of Ukraine, Ukraine [118]
- *Andrii Striuk*, Kryvyi Rih National University, Ukraine [63]
- *Tetiana Vakaliuk*, Zhytomyr Polytechnic State University, Ukraine [140]

1.2.3. General chair

Dr. Stamatios Papadakis (figure 2) has been a postdoctoral researcher in Educational Technology, with an emphasis on mobile learning, at the Department of Preschool Education at the University of Crete, Greece, since 2016. He graduated from the Department of Informatics, Athens University of Economics and Business, Athens, Greece. In 2006 he completed a master's

degree (M.Ed.) in Pre-school Education and Educational Design at the University of Aegean, Rhodes, Greece, at the School of Humanities, Department of Pre-school Education. In 2016, he completed a PhD at the University of Crete, Department of Education in Rethymnon, Greece. He has worked as an adjunct Lecturer in Education, teaching Didactics in Programming (2017-2018) at the Department of Computer Sciences, School of Sciences and Engineering at the University of Crete, Greece. Since 2017 he has worked as an adjunct Lecturer in Education teaching Informatics (2017-2018) at the Department of Preschool Education, School of Education, University of Crete, Greece.

He has worked in several international and national computational thinking and pedagogy projects for Pre-K to 16 Education. His scientific and research interests include the study of mobile learning, especially on using smart mobile devices and their accompanying mobile applications (apps) in Preschool and Primary Education, focusing on developing Computational Thinking and students' understanding of numbers. Furthermore, he currently investigates how a STEM learning approach influences learning achievement through a context-aware mobile learning environment in the preschool classroom and explain the effects on preschoolers' learning outcomes.

Languages: English (fluent), German.

He is an ambassador for Scientix – The Community for Science Education in Europe and EU Code Week. He is an ESERA member, CSTA, EAI, IGIP, and the Union for Science and Technology (ENEPHET).

He has published in scientific peer-reviewed journals and international conferences (including *Computers & Education*, *Education and Information Technologies*, *Early Childhood Education Journal*) and book chapters.

WWW: <https://ptpe.edc.uoc.gr/en/staff/32380/82>

ResearchGate: https://www.researchgate.net/profile/Stamatios_Papadakis

Academia: <https://independent.academia.edu/PapadakisStamatis>

Google Scholar: <https://scholar.google.gr/citations?user=e3vLZegAAAAJ&hl=en>

ORCID: <https://orcid.org/0000-0003-3184-1147>

Scopus: <https://www.scopus.com/authid/detail.uri?authorId=57038471800>

dblp: <https://dblp.org/pers/hd/p/Papadakis:Stamatis>

Web of Science: <https://www.webofscience.com/wos/author/record/S-1483-2016>

AD Scientific Index: <https://www.adscientificindex.com/scientist.php?id=1846783>

Research website: <http://moeads.edc.uoc.gr/>

Selected works: Ampartzaki, Kalogiannakis and Papadakis [9], Chatzopoulos et al. [33], Dorouka, Papadakis and Kalogiannakis [38], Drolia et al. [39], Karakose, Yirci and Papadakis [57], Lavidas, Apostolou and Papadakis [78], Papadakis [104, 105, 106, 107, 108], Papadakis, Alexandraki and Zaranis [109], Papadakis et al. [110], Vaiopoulou et al. [138], Zourmpakis, Papadakis and Kalogiannakis [154].



Figure 2: Dr. Stamatios Papadakis, CITED 2022 general chair.

2. Articles overview

2.1. Digital Transformation of Education

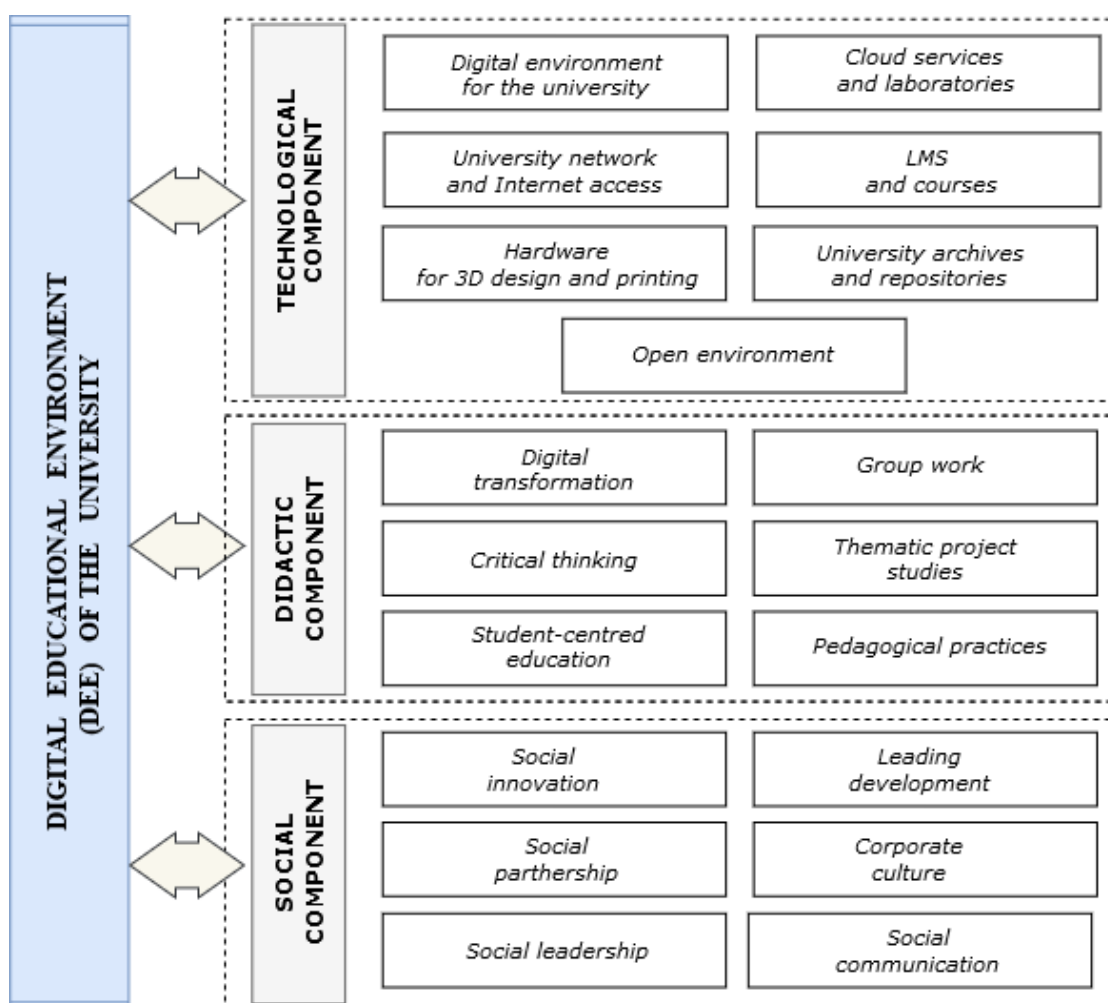


Figure 3: Presentation of paper [18].

The paper “Exploring modern trends in developing a digital educational environment for university: A case study of Ternopil Volodymyr Hnatiuk National Pedagogical University” [18] by Nadiia R. Balyk, Galyna P. Shmyger, Yaroslav Ph. Vasylenko and Vasyl P. Oleksiuk (figure 3) examines the current trends in the development of digital educational environments within universities and proposes a model for their effective implementation in pedagogical institutions. The study investigates the concept of educational environments, analyzes their components, and identifies their unique structural characteristics. Furthermore, it introduces the concept of a digital educational environment and delineates its key components for teachers’ professional training at Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU), namely the

technological, didactic, and social aspects. Noteworthy features of this environment, such as its information-rich and open nature, digital transformation, and emphasis on social practices and collaboration, are also discussed. To assess the efficacy of the digital educational environment for teachers' professional training, a comprehensive study was conducted involving 432 master's students from various disciplines at TNPU. Utilizing expert assessments for statistical analysis, the study determined the significance of each component's indicators within the digital educational environment. The findings reveal significant changes in the technological and social dimensions of the university's digital educational environment, which have a substantial impact on the quality of teachers' professional training.

The authors' related works are referenced as [17, 25, 102].

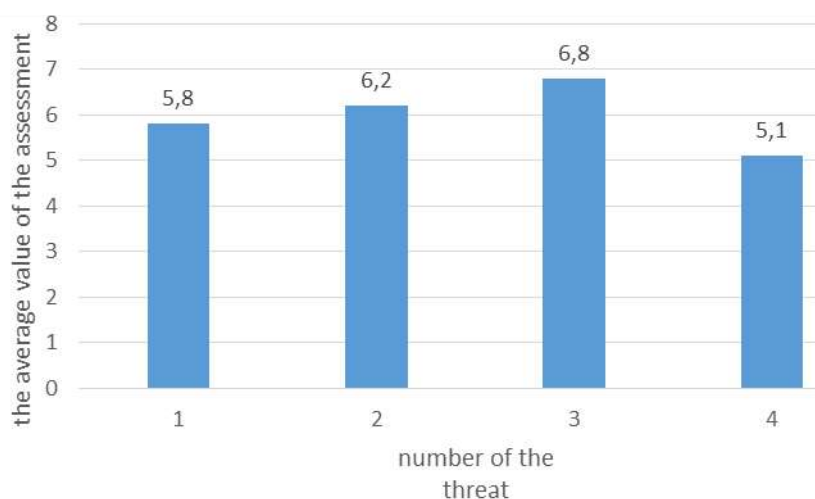


Figure 4: Presentation of paper [61].

The study “Exploring the landscape of e-learning for lifelong education of public servants: trends, challenges, and implications” [61] by Yevhen M. Khrykov, Olga M. Ptakhina, Tetiana V. Sych and Dmytro I. Dzvinchuk (figure 4) presents a comprehensive examination of the components that constitute the lifelong education system for public servants. Emphasizing the importance of e-government in public administration, the study explores the role of e-learning as a vital tool for equipping public servants to effectively engage in e-governance. Drawing on both national and international experiences, the research investigates various modalities of e-learning, including distance education, blended learning, and integration with traditional classroom approaches. By conducting a survey among civil servants who underwent Information and Communication Technology (ICT) training at Ukrainian higher educational institutions, the study evaluates the potential benefits and threats associated with ICT training. Moreover, through an analysis of scientific and empirical evidence, the article identifies emerging trends in e-learning development and highlights countries that exemplify effective strategies to address current challenges. This article serves as a valuable resource for understanding the evolving landscape of e-learning in lifelong education for public servants, shedding light on emerging trends, inherent challenges, and their wider implications for fostering effective governance.

The authors' related works are referenced as [60, 62, 136].

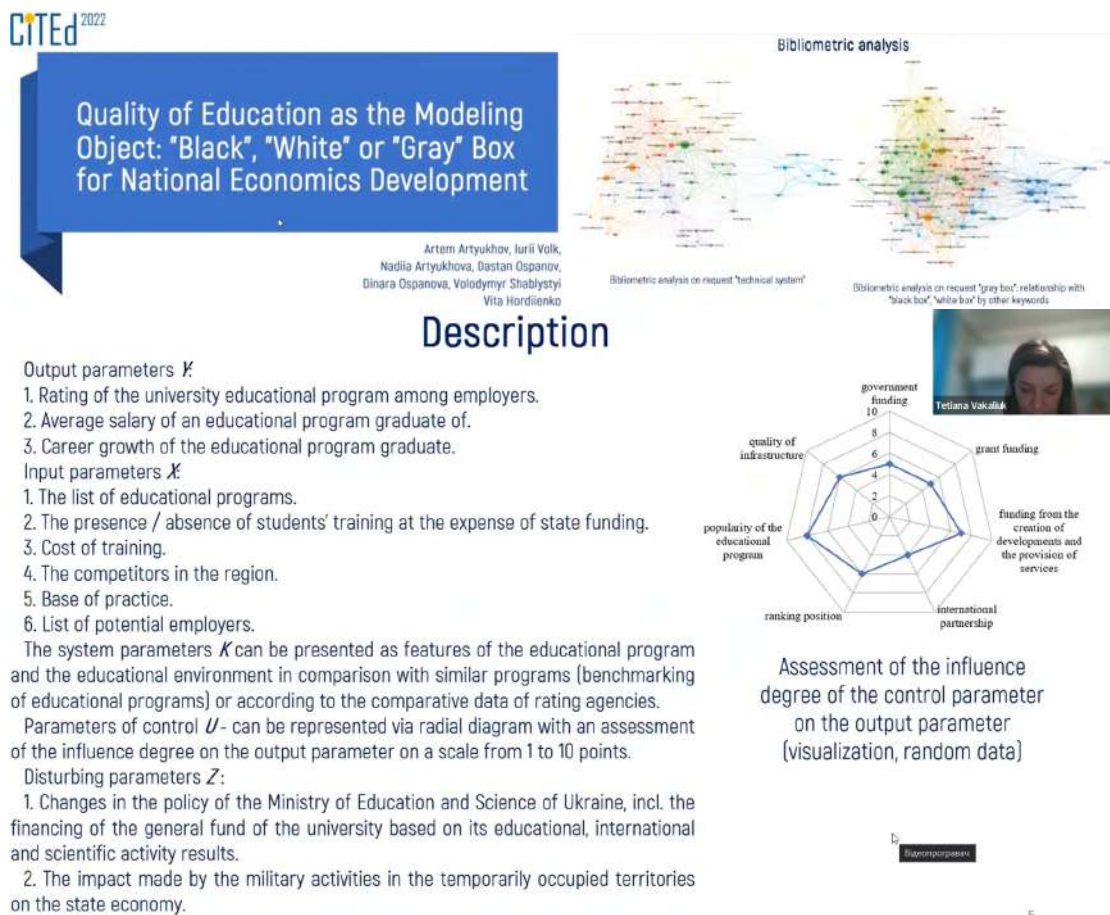


Figure 5: Presentation of paper [11].

The paper “Quality of education as the modeling object: “black”, “white” or “gray” box for national economics development” [11] by Artem Artyukhov (figure 5), Iurii Volk, Nadiia Artyukhova, Dastan Ospanov, Dinara Ospanova, Volodymyr Shablysty and Vita Hordienko presents a modeling approach to analyze the dynamic “quality of education” system, considering various parameters such as initial data, control parameters, disturbing parameters, and output parameters. By drawing analogies with tangible objects, authors obtain a detailed description of the system’s internal and external factors, enabling the prediction of its response to changes in power elements. Authors identify the key properties of the quality of education system, such as purposefulness, hierarchy, interdependence with the external environment, autonomy, openness, reliability, and dimension. Their proposed algorithm for transitioning between models, from black to gray box and then to white box models, provides a comprehensive description of input and output parameters with increasing determinism. The modeling approach presented in this paper can be used to analyze and improve the quality of education systems.

The authors' related works are referenced as [13, 81, 131].



Evaluation of the System "Quality of Education" and Its Socio-Economic Impact: Analogies with Software Testing

Artem Artyukhov, Iurii Volk,
Nadiia Artyukhova, Roman Halenin,
Liudmyla Batsenko

Background: formation of the educational structure and its tes

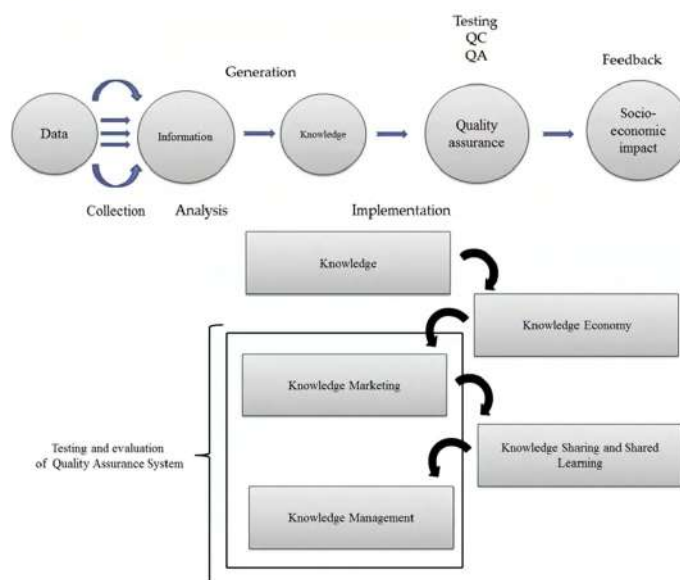


Figure 6: Presentation of paper [10].

The paper “Evaluation of the system “quality of education” and its socio-economic impact: analogies with software testing” [10] by Artem Artyukhov (figure 6), Iurii Volk, Nadiia Artyukhova, Roman Halenin and Liudmyla Batsenko presents a reliable algorithm for testing the quality of education systems and its relationship with sustainable development goals. Drawing analogies with software testing, we propose a framework for evaluating educational

programs that align with SDG 4 “Quality Education” and SDG 8 “Decent Work and Economic Growth”. Through bibliometric analysis, authors identify indicators of the socio-economic impact of the education system. They provide a general algorithm for testing the design and a structural and logical diagram for testing both internal and external aspects of the system. The proposed framework can be used to improve the quality of education systems and contribute to sustainable development.

The authors’ related works are referenced as [12, 146, 147].

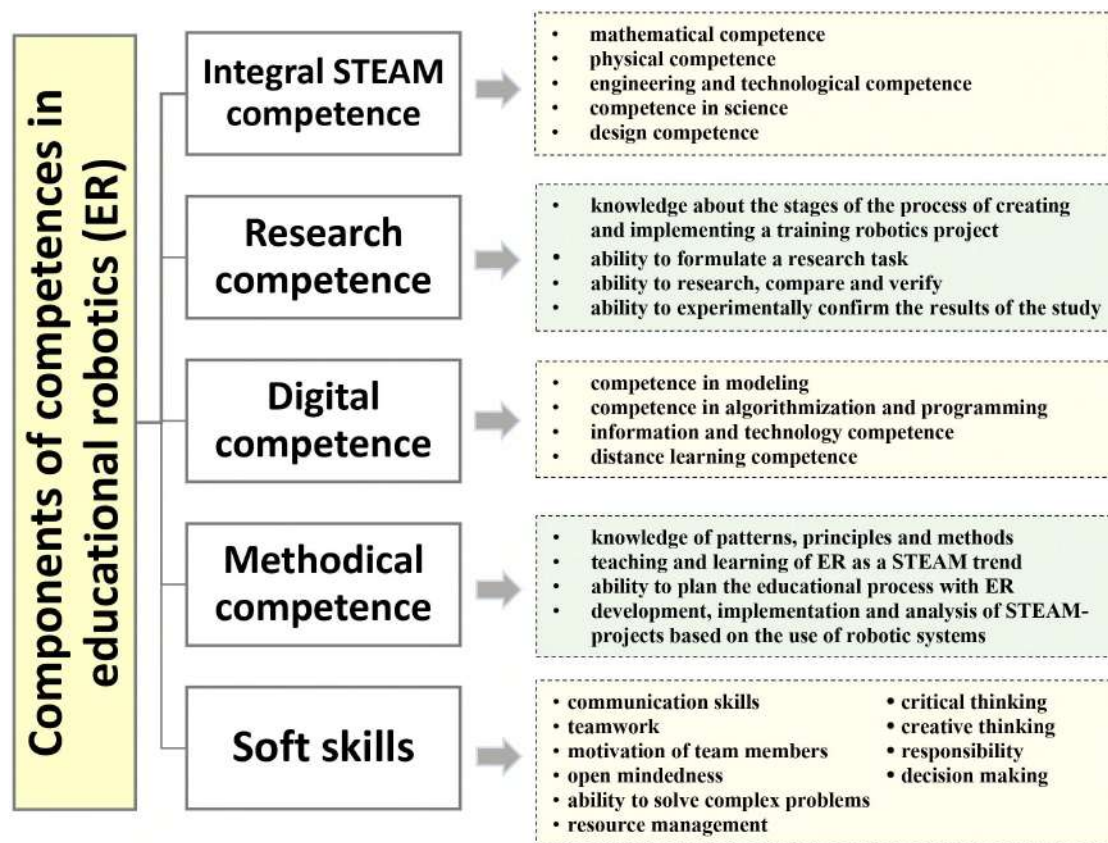


Figure 7: Presentation of paper [97].

The rapid expansion of robotics as an applied industry has created a significant demand for robotics specialists skilled in the development, design, and programming of robots. Consequently, educational robotics has gained immense popularity as a global educational trend, including in Ukraine. Integrating educational robotics into STEAM education offers a powerful platform for fostering students’ soft skills, enabling them to tackle real-world socially significant projects and bridging the gap between theory and practice. To meet this growing demand, it is crucial to equip pre-service teachers with the necessary skills to effectively teach educational robotics. The article “Advancing educational robotics: competence development for pre-service computer science teachers” [97] by Nataliia V. Morze and Oksana V. Strutynska (figure 7) addresses the establishment of a comprehensive model for developing competences in educational

robotics among teachers. The study highlights that pre-service computer science teachers demonstrate the highest readiness to teach educational robotics in secondary schools. The article focuses on the development and validation of a competence model specifically tailored for pre-service computer science teachers, emphasizing its effectiveness through the teaching of educational robotics disciplines. By enhancing teachers' competences, this study aims to promote the integration of educational robotics in classrooms, empowering students to thrive in a digitally-driven society.

The authors' related works are referenced as [94–96].



Figure 8: Presentation of paper [117].

The article “Web-oriented encyclopedic edition as a tool for dissemination of verified knowledge in the field of education” [117] by Olha P. Pinchuk and Liliia A. Luparenko (figure 8) presents the development of the “Ukrainian Electronic Encyclopedia of Education” by the Institute for Digitization of Education of the National Academy of Educational Sciences of Ukraine (IDE NAES of Ukraine). The project aims to create a web-oriented encyclopedia to support the terminology of education and psychology. The initial stages of implementation procedure are discussed, including the structure of the website, software platform, functionality, search toolkit, articles typology, thematic sections, authors' team, and target audience. To inform this

development, the authors analyzed key reference resources regarding encyclopedic editions, such as the Corpus of Ukrainian Encyclopedias, Electronic Library of the NAES of Ukraine, V. O. Sukhomlynskyi State Scientific and Pedagogical Library of Ukraine, and ScienceDirect. A review of international scientific publications was conducted, which highlighted the need for open use of verified, scientific, and succinctly presented content. The authors also emphasize the need for technical and technological implementation to support content uploading, editing, and enhancing, as well as the coordinated work of an international scientific authors' team, open access for many users, and search functions by various parameters on the site.

The authors' related works are referenced as [82, 83, 134].

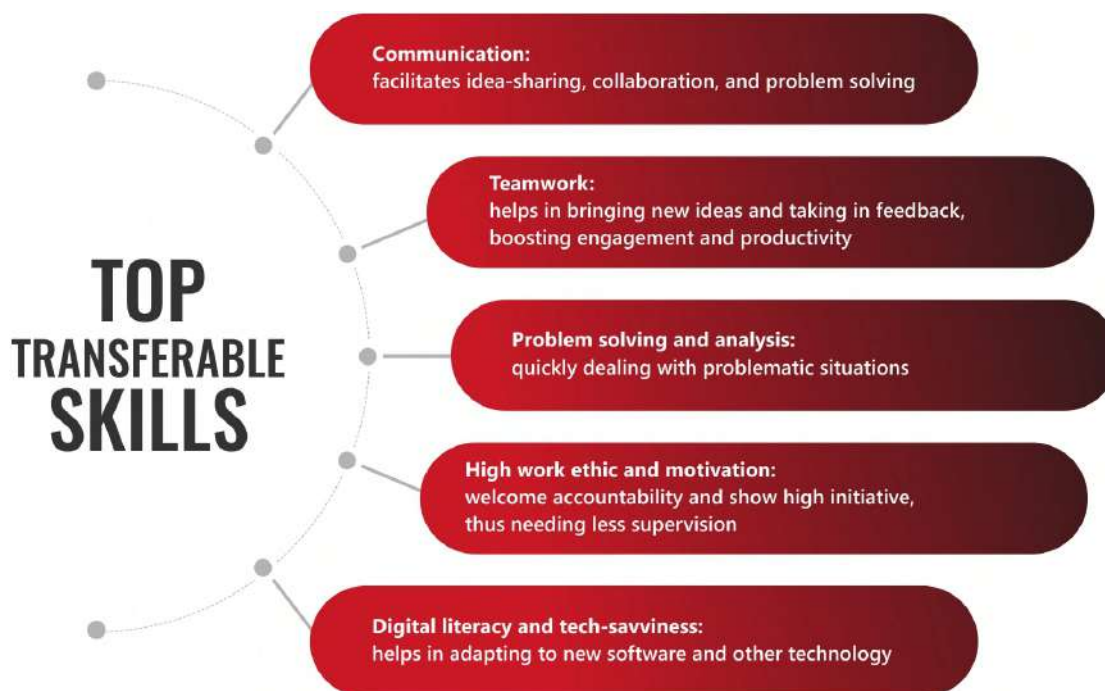


Figure 9: Presentation of paper [7].

The study “The use of transferable skills in education and its impact on the economy” [7] by George Abuselidze and Gia Zoidze (figure 9) aims to investigate the root cause of students’ lack of development and implementation of transferable skills. The research employs secondary data, public documents, and content analysis methods to examine the current changes in the education system. Additionally, a PESTEL analysis is conducted to explore the factors of internationalization in the Georgian educational market, taking into account political, economic, social, technological, ecological, and legal factors that contribute to the attractiveness of Georgia to foreign students. The importance of this topic lies in the fact that transferable skills are essential for success in modern society. The current global situation necessitates the emergence of young people who can independently apply their knowledge to the economy and culture. By teaching effective transferable skills, we can not only address the current unsustainable situation but also promote demand, productivity, and economic growth. The paper concludes with recom-

recommendations for higher educational institutions and students. The research findings can serve as a valuable contribution to the development of an effective state policy for university education. This is particularly crucial in the post-pandemic period, where innovation acceleration and rational economic wealth accumulation are vital for the country's advancement.

The authors' related works are referenced as [3–5].

Национальний університет водного господарства та природокористування

National University of Water and Environmental Engineering

THE MANAGEMENT STRATEGY IN THE EDUCATIONAL INSTITUTION DURING THE CRISIS CAUSED BY COVID-19 PANDEMIC

Yelyzaveta Mykhallova, Natalia Savina and Ihor Tymoschuk

National University of Water and Environmental Engineering
Ukraine, 33028, Rivne city, 11 Soborna St., NUWEE

The management strategy in education institution

VIRTUALIZATION

VIRTUALISATION of the educational institution involves the creation of the virtual market, virtual reality and virtual organization with the help of information and communication technologies.

HR POLICY focuses on controlling budget expenditures, employee satisfaction, training and development, conflict resolution and productivity.

BRANDING is a key element, which implementation helps to stand out from the competition, build brand awareness, create lasting experience with the brand, connect with the audience and turn them into loyal customers.

For the first time, it was set conceptual approaches to the formation of the management strategy of the educational institution as the participant of educational activities, with the basis on hi-tech, hi-human and hi-sensor, that allows to make systemic management decisions that reduce the negative impact of the crisis caused by the Covid-19 pandemic.

the development of the NUWEE web-site to the educational portal: nuwm.edu.ua

the development of NUWEE application, where all the participant can find all services provided by university

the development of the electronic document management system, the providing of which was during the pandemic, but till now it's developing: idoc.nuwm.edu.ua

Website, application and system of electronic document circulation at the NUWEE

Figure 10: Presentation of paper [99].

The unprecedented COVID-19 pandemic has caused a significant economic crisis that has impacted educational institutions worldwide. The article “The management strategy in the educational institution during the crisis caused by COVID-19 pandemic” [99] by Yelyzaveta Mykhallova (figure 10), Natalia Savina and Ihor Tymoschuk examines the effects of this crisis on education, including a reduction in funding and a decrease in the number of participants in the educational process. Additionally, there is an internal crisis within the education sector, characterized by a reduction in the quality of education and a lack of necessary forms of education to meet the demands of an information-driven society.

The goal of this research is to analyze the ability of education to overcome the negative impacts of economic crises and adapt to the changing needs of society. To achieve this goal, an anti-crisis management strategy has been developed, targeting the most problematic components of the

educational sphere, including funding, the number of participants and institutions, quality, and forms of education. This strategy involves three main components, namely virtualization, HR policy, and branding.

The success of this anti-crisis management strategy has been demonstrated in the years 2020-2021. Therefore, this research provides a theoretical basis for the transformation of education, enabling it to be adapted to the needs of modern society. This article emphasizes the importance of addressing the negative impact of the COVID-19 pandemic on education and highlights the need for innovative solutions to enable educational institutions to thrive despite these challenging times.

The authors' related works are referenced as [84–86].

2.2. Cloud-based AI Education Applications

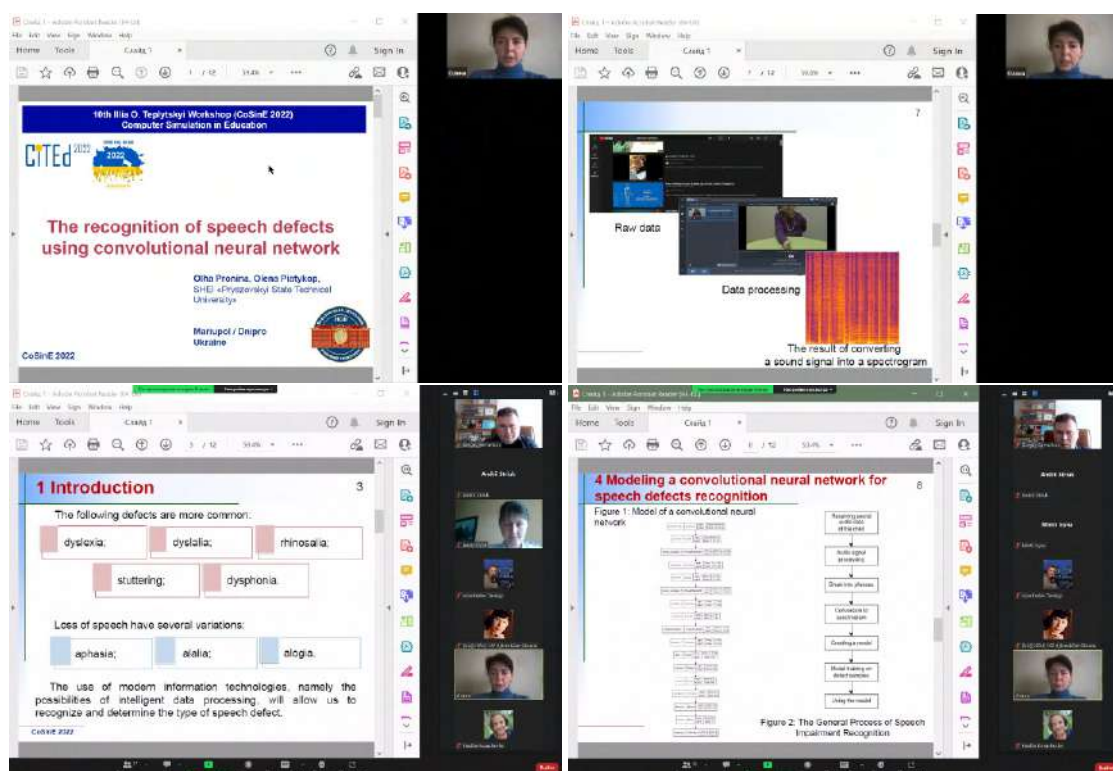


Figure 11: Presentation of paper [124].

In their article titled “The recognition of speech defects using convolutional neural network” [124], Olha Pronina and Olena Piatyko (figure 11) present a solution to improve the recognition efficiency of speech defects in children by utilizing convolutional neural network models to process spectrogram-based sound data. The ability to communicate effectively through speech is crucial for successful integration into society, and speech development is an essential part of a child’s normal growth. Speech defects can cause psychological complexes in children, making it

important to identify and address them at an early age. The authors conduct a literature analysis and propose the use of CNN models for speech defect identification, with a focus on Ukrainian language, which has not been studied in this context. The paper includes a mathematical model of oral speech disorders in children, a description of CNN structure, and experimental results. The results show that the proposed method can identify dyslexia, stuttering, difsonia, and dyslalia with a recognition accuracy of 77-79%. The authors' related works are referenced as [116, 122, 123].

2.3. Cloud-based Learning Environments

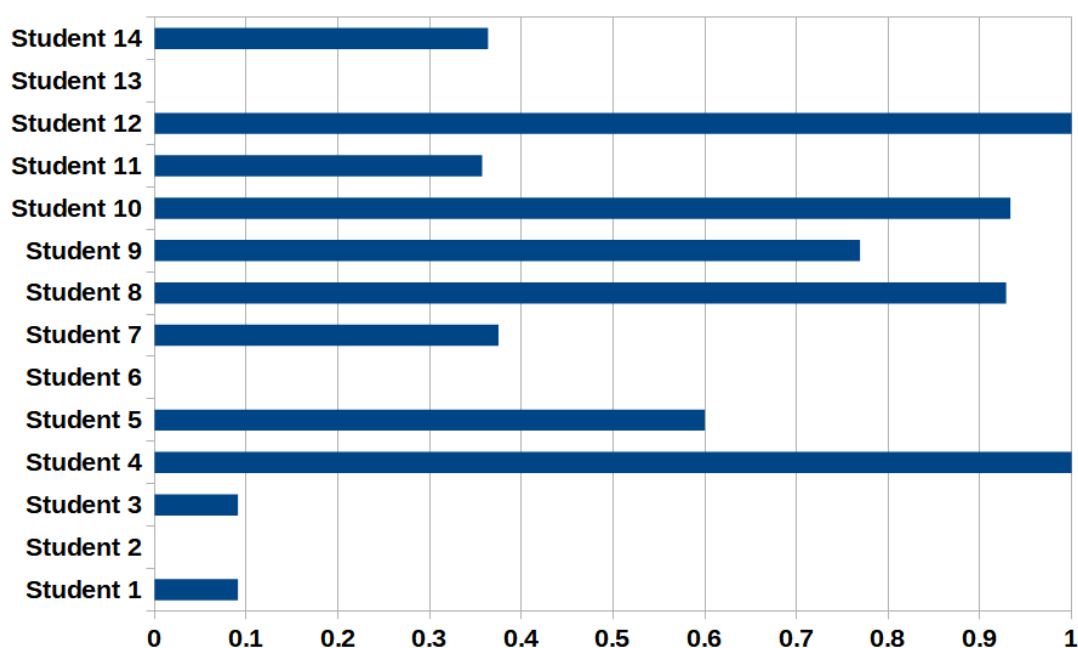


Figure 12: Presentation of paper [68].

The research paper “Enhancing out-of-class independent learning in a cloud-based information and communication learning environment: insights from students of a pedagogical university” [68] by Oleksandr H. Kolgatin, Larisa S. Kolgatina and Nadiia S. Ponomareva (figure 12) addresses the challenges associated with students’ out-of-class independent work in an information and communication learning environment that leverages cloud technologies. Drawing upon survey data collected from students at a pedagogical university, the study informs the development of a course titled “Educational Electronic Resources for Primary School”, tailored for future primary school teachers. The findings shed light on significant issues, including the need for clearer instructions aligned with task requirements, limited self-management skills, and a lack of intrinsic motivation. Students emphasized the importance of detailed instructions, either provided orally or in written form, as well as careful time planning to ensure successful task completion. Additionally, the article discusses students’ learning activities and achieve-

ments within the course amidst the challenges posed by the COVID-19 pandemic. Building on this analysis, the study formulates essential requirements for effectively managing students' out-of-class independent work in a cloud-based learning environment. This research contributes valuable insights to enhance the design and implementation of remote learning initiatives, foster student engagement, and promote meaningful learning outcomes.

The authors' related works are referenced as [21, 22, 67].

2.4. Cloud-based E-learning Platforms, Tools and Services

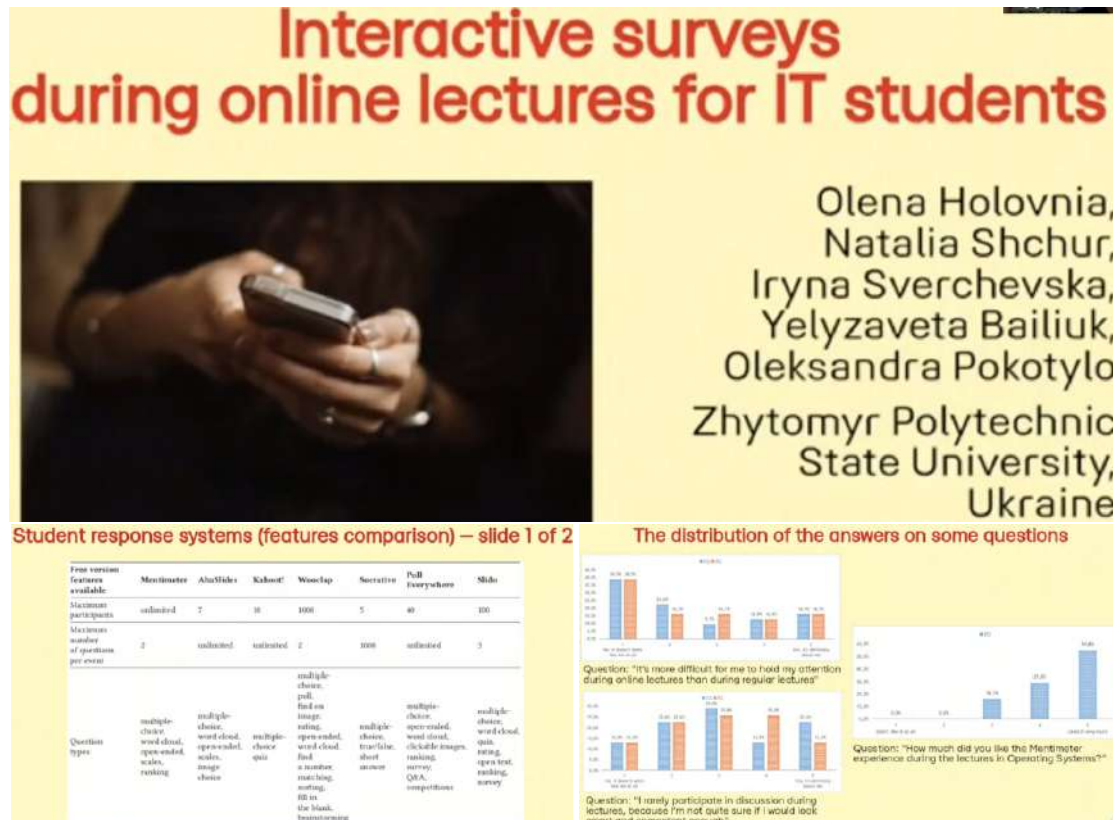


Figure 13: Presentation of paper [50].

The use of student response systems (SRS) has gained significant attention in recent years as a tool for increasing student engagement and improving the overall learning experience during online lectures. In the study “Interactive surveys during online lectures for IT students” [50], Olena S. Holovnia (figure 13), Natalia O. Shchur, Iryna A. Sverchevska, Yelyzaveta M. Bailiuk and Oleksandra A. Pokotylo provide a comprehensive overview of different SRS platforms such as Mentimeter, AhaSlides, Kahoot!, Wooclap, Socrative, Poll Everywhere, and Slido, and compare their features to determine their suitability for facilitating students' engagement in online lectures.

The authors then present their experience using Mentimeter in the Operating Systems course for second-year IT students of Zhytomyr Polytechnic State University with specializations in Software Engineering, Computer Science, Computer Engineering, and Cybersecurity. The study collects data through observation, surveys, and existing data and uses visual and statistical analyses to analyze the data. The study reports an increase in the number of students' answers within the lectures and highlights IT students' problems and preferences during online lectures.

Holovnia et al. [50] provide recommendations for using SRS during online lectures to improve the interaction between the lecturer and the audience, including increasing the number of questions, reducing the time between questions, and using open-ended questions to encourage critical thinking. This study contributes to the literature on SRS in online learning and provides valuable insights for educators seeking to enhance student engagement and learning outcomes in online lectures.

The authors' related works are referenced as [48, 49, 133].

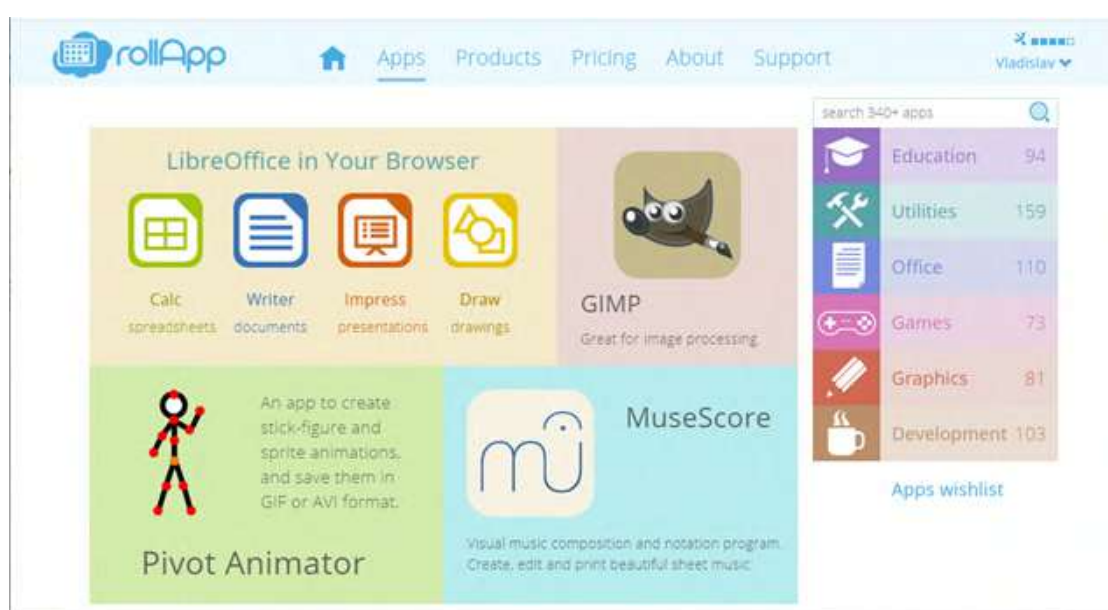


Figure 14: Presentation of paper [144].

The paper "Exploring the potential of online services in utilizing free software for educational activities" [144] by Vladyslav Ye. Velychko, Svitlana O. Omelchenko and Elena G. Fedorenko (figure 14) explores the integration of free software into educational settings through the use of online services. Free software, rooted in principles of freedom and intellectual creativity, offers numerous possibilities, yet its incorporation into educational activities remains limited. By employing questionnaires, analyzing open data, and reviewing existing research, this study examines the factors that either facilitate or hinder the adoption of free software in education. The findings provide valuable insights into the feasibility of integrating free software into educational contexts and present specific examples of its usage. Moreover, the study emphasizes the role of online resources in introducing educators and learners to free software, underscoring

its central focus. By shedding light on the potential benefits and challenges of incorporating free software in education and highlighting the importance of online services, this article contributes to the discourse surrounding the integration of free software in educational settings.

The authors' related works are referenced as [41, 42, 143].

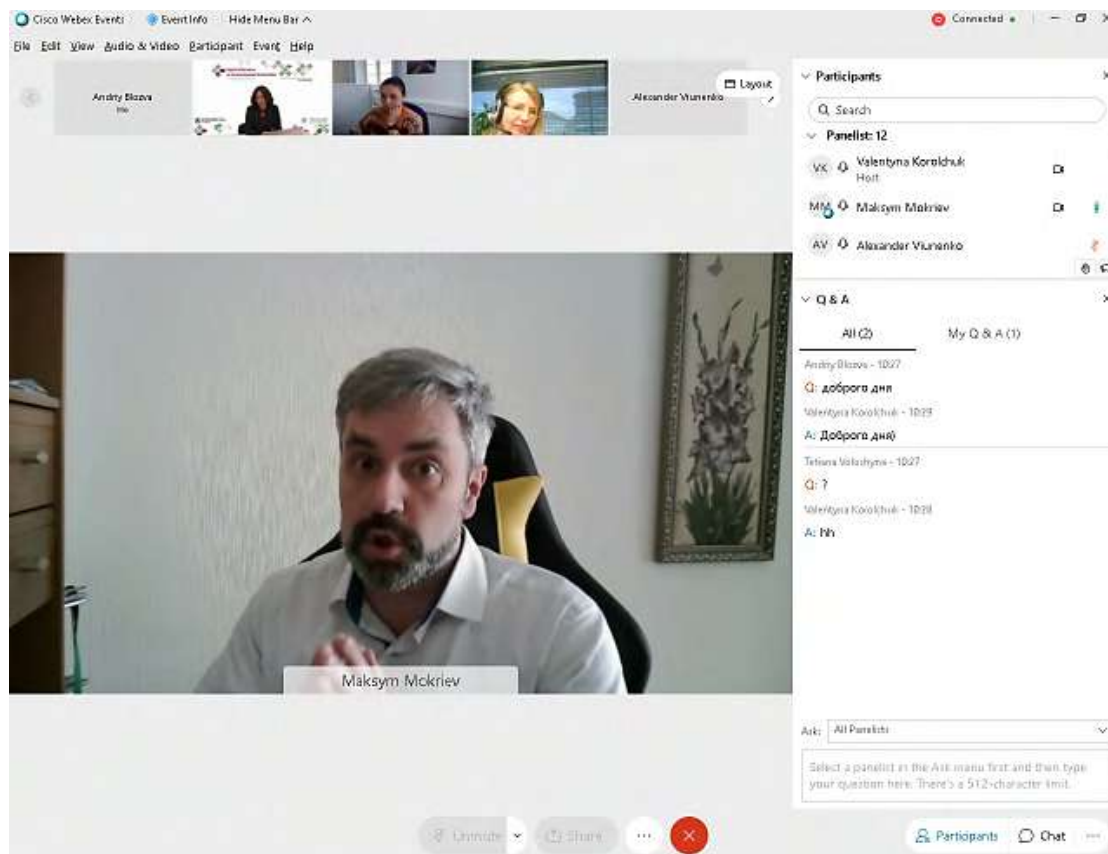


Figure 15: Presentation of paper [44].

The COVID-19 pandemic has underscored the importance of thoroughly assessing the effectiveness of e-learning implementation models and associated resources in higher education institutions. In their talk “Effectiveness analysis of e-learning implementation models and resource support in higher education institutions: case studies and insights amidst the COVID-19 pandemic” [44], Olena G. Glazunova, Maksym V. Mokrîiev, Olena H. Kuzminska, Valentyna I. Korolchuk, Nataliia V. Morze, Liliia O. Varchenko-Trotsenko and Roman A. Zolotukha (figure 15) offers a comprehensive overview of solutions and case studies, focusing on the selection and evaluation of individual services and learning management platforms. To ensure the efficacy of electronic resources in meeting students’ educational needs, the study recommends combining quantitative indicators with students’ performance descriptions. This involves leveraging educational analytics to collect data on students’ frequency and duration of interaction with specific e-resources. The article examines the functionality modules “Course Comparison” within the Moodle Learning Management System (LMS), “Statistics”, and the optional Analytics

module. It presents the results of applying these modules to analyze e-learning courses at the National University of Life and Environmental Sciences of Ukraine and Boris Grinchenko Kyiv University. Furthermore, the study investigates the factors contributing to students' limited usage of individual e-courses. By scrutinizing these case studies and shedding light on the underlying reasons for reduced student engagement, this article provides valuable insights to enhance the effectiveness of e-learning implementation and resource support in higher education institutions.

The authors' related works are referenced as [77, 121, 153].

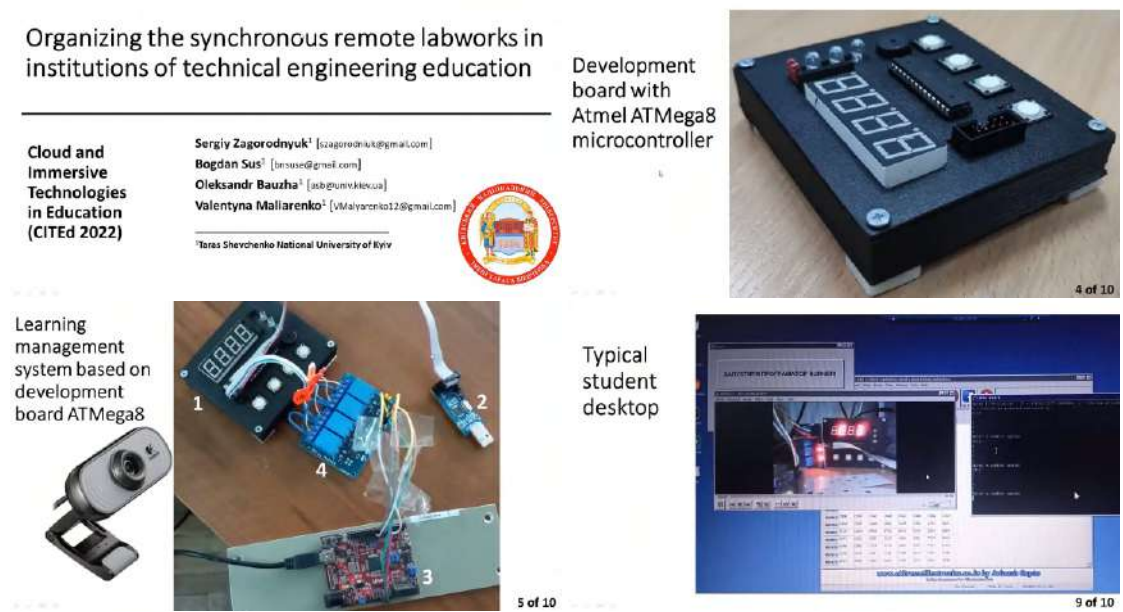


Figure 16: Presentation of paper [152].

The article “Organizing the synchronous remote labworks in institutions of technical engineering education” [152] presents a comprehensive discussion on the implementation of a synchronous remote labwork system. Sergiy P. Zagorodnyuk, Bogdan B. Sus (figure 16), Oleksandr S. Bauzha and Valentyna M. Maliarenko present an innovative approach to controlling arbitrary laboratory devices, which ensures effective operational interaction between teachers and students, and provides complete control over the quality and completeness of labwork. The proposed system comprises a microcontroller development board, broadcast imaging device, and assistant microcontroller with 4-pole relay, and can accommodate any number of students remotely connecting and operating on a computer. The authors also discuss the coordination of students' actions, and demonstrate that with the program functioning optimally, students can spend up to 90% of their time developing and utilizing the working time of computers and laboratory devices efficiently. The article also includes a program structure of the additional microcontroller Chipkit that allows students to operate with real laboratory hardware in the mode of synchronous remote laboratory work. Overall, this article provides valuable insights and practical suggestions for the development and implementation of remote labwork systems,

which have become increasingly relevant in light of recent global events.

The authors' related works are referenced as [30, 34, 135].

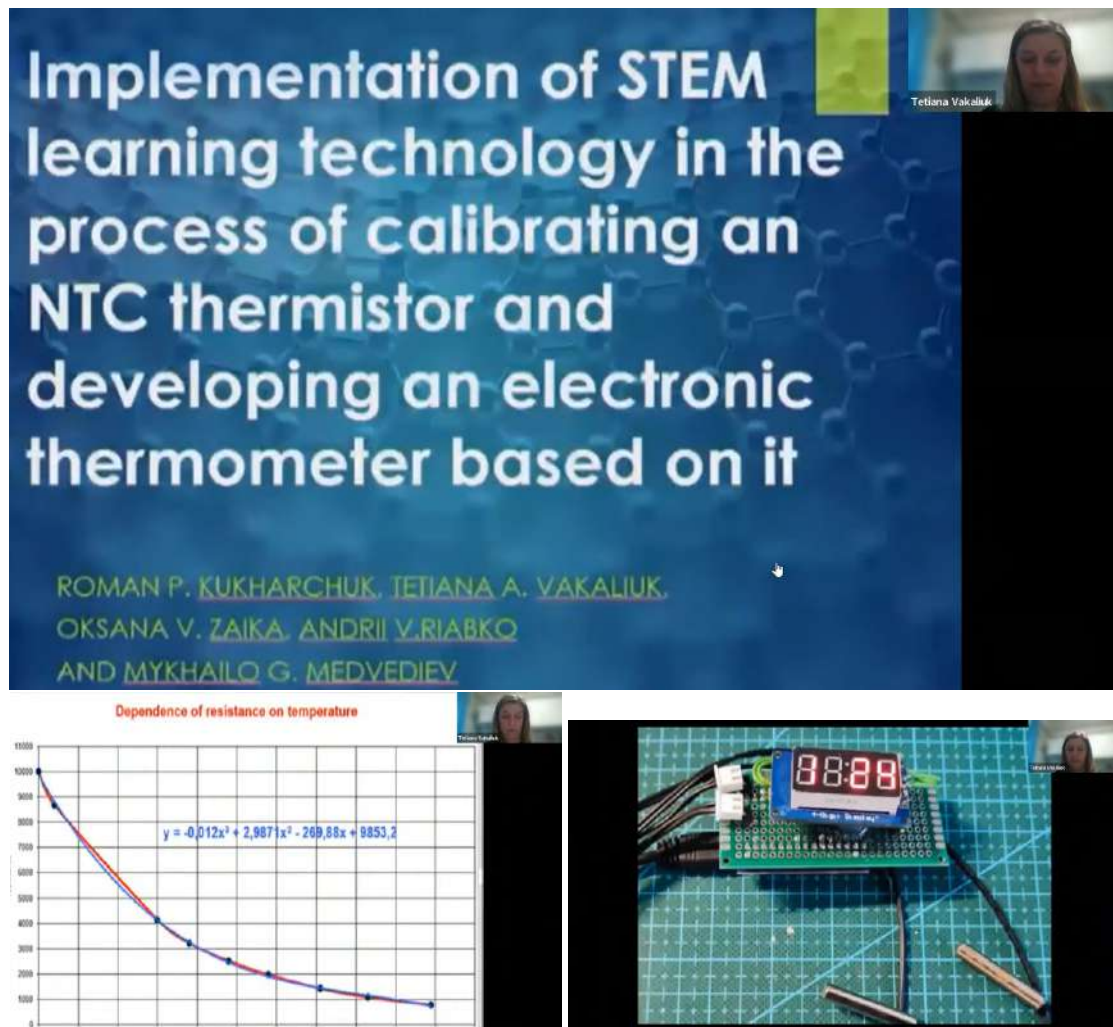


Figure 17: Presentation of paper [74].

The progress of information technology, robotics, nanotechnology, and biotechnology has resulted in a demand for highly skilled professionals who can adapt to new challenges and innovate creatively. To meet this need, there is an urgent requirement to reform education and prepare students for popular careers such as programming, engineering, biotechnology, nanotechnology, and IT. STEM education can integrate these fields into a comprehensive curriculum that can be applied to different age groups. The authors propose a method for calibrating an NTC thermistor using STEM technologies and demonstrate the development of an electronic thermometer using an Arduino microcontroller. The article “Implementation of STEM learning technology in the process of calibrating an NTC thermistor and developing an electronic thermometer based on it” [74] by Roman P. Kukharchuk, Tetiana A. Vakaliuk

(figure 17), Oksana V. Zaika, Andrii V. Riabko, and Mykhailo G. Medvediev describes this approach and builds upon the authors' previous work [127, 128, 139].

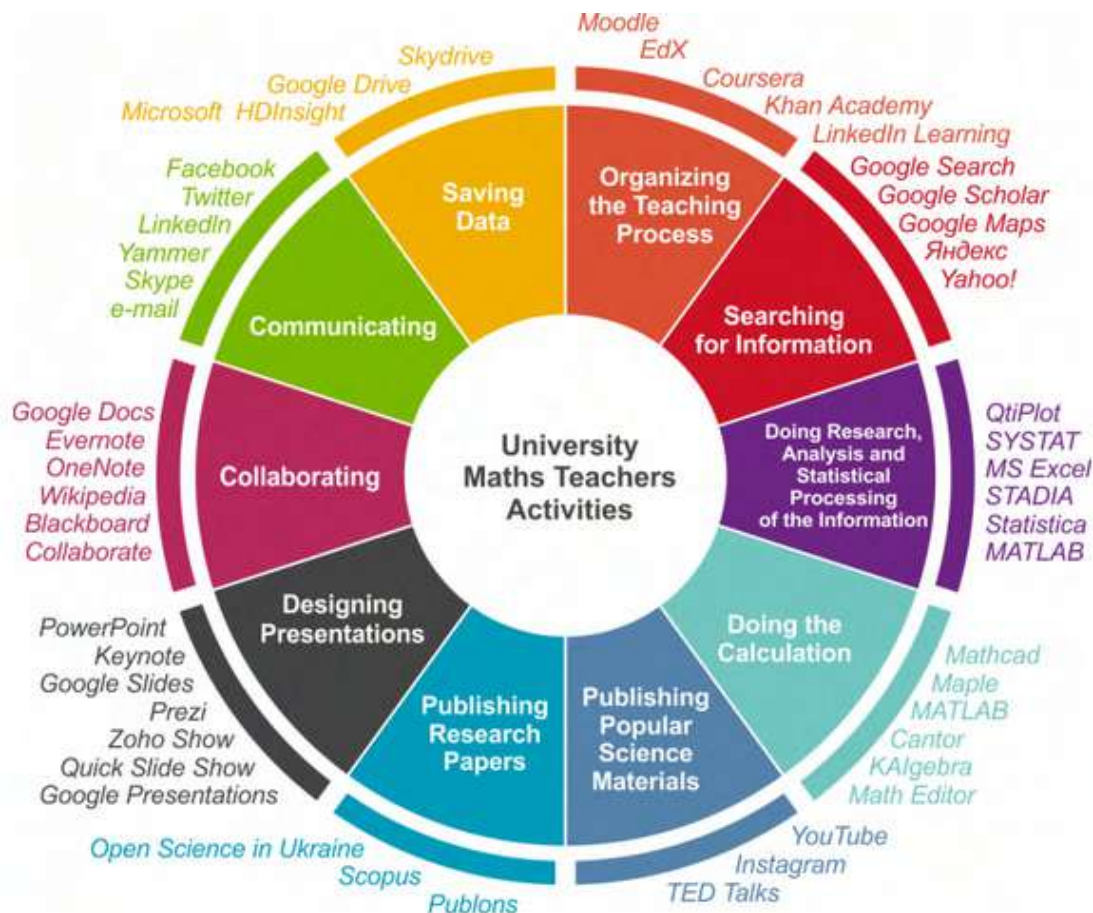


Figure 18: Presentation of paper [8].

The article “Web-based support for higher school teachers: insights from a survey and theoretical analysis” [8] by Vitaliy V. Achkan, Kateryna V. Vlasenko, Iryna V. Lovianova, Olha H. Rovenska, Iryna V. Sitak and Olena O. Chumak (figure 18) examines the theoretical aspects of incorporating Web 2.0 technology in higher education. By analyzing the responses of 87 participants, the study identifies the types of activities carried out by higher education teachers and explores the Web 2.0 tools that can enhance instructional practices. Through a comprehensive theoretical analysis of existing research and resources, the article highlights the common characteristics of online courses and discusses principles for effectively utilizing online systems in the Web space. The findings support the feasibility of promoting online courses to familiarize Mathematics teachers with the technical capabilities of creating educational content using Web 2.0 technology. This research contributes valuable insights into the theoretical foundations of Web 2.0 technology in higher education and provides recommendations for integrating these tools into instructional practices.

The authors' related works are referenced as [70, 145, 148].

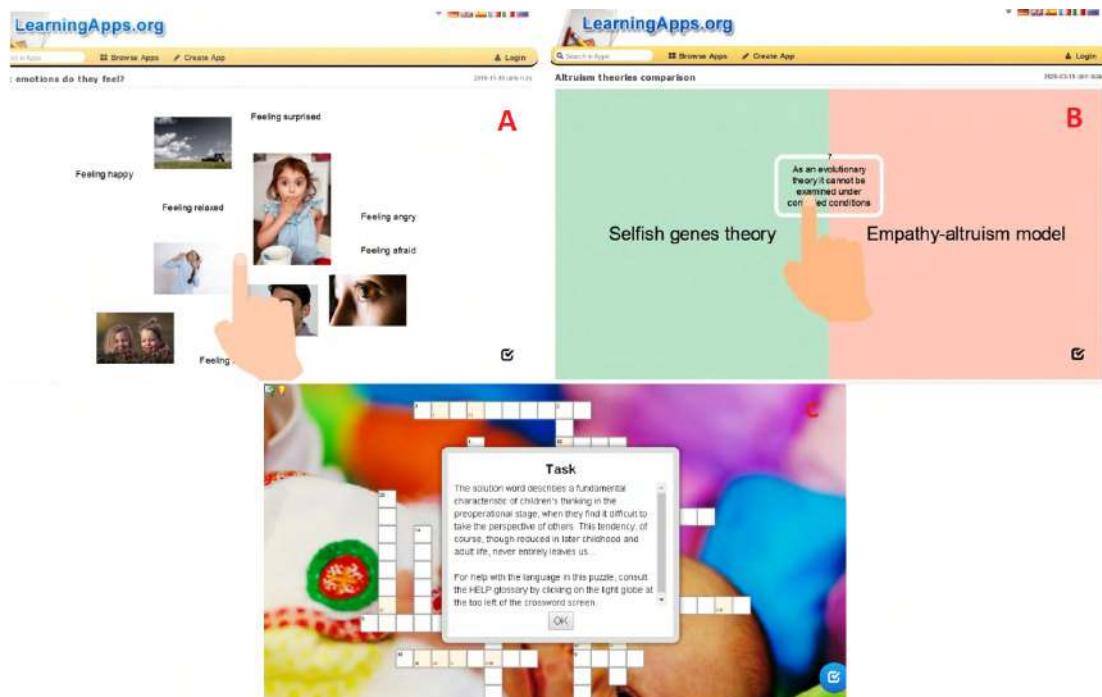


Figure 19: Presentation of paper [142].

The article “Enhancing adaptive learning: leveraging interactive exercises through the LearningApps service” [142] by Hanna B. Varina, Viacheslav V. Osadchy and Svetlana V. Shevchenko (figure 19) delves into the potential of adaptive learning systems in fostering optimal intellectual development for students based on their unique abilities and inclinations. It highlights the advantages of incorporating interactive exercises through the utilization of the LearningApps service’s technical capabilities. The paper showcases the practical implementation of a personalized approach to education using the LearningApps service. Additionally, it presents empirical findings from a study conducted with first-year students in psychological disciplines, investigating the integration of the LearningApps service in the educational process. The study’s statistical data demonstrates the effectiveness and relevance of the LearningApps service in enhancing the motivational component of professional training for future professionals within the adaptive learning framework. This research sheds light on the possibilities of adaptive learning systems and their potential to enhance student engagement and motivation in education.

The authors' related works are referenced as [59, 103, 141].

2.5. Immersive Technology Applications in Education

The paper “Using a mobile application to teach students to measure with a micrometer during remote laboratory work” [56] presents the experience of developing and using a mobile applica-

USING A MOBILE APPLICATION TO TEACH STUDENTS TO MEASURE WITH A MICROMETER DURING REMOTE LABORATORY WORK

Oleksandr V. Kanivets
Irina M. Kanivets
Tetyana M. Gorda
Oleksandr V. Gorbenko
Anton O. Kelemesh

Poltava – 2022

THE MAIN SCREEN OF THE PROGRAM

THE SCENE OF PRACTICAL TRAINING

Figure 20: Presentation of paper [56].

tion for teaching micrometer measurements during remote laboratory work in higher education. The Oleksandr V. Kanivets, Irina M. Kanivets, Tetyana M. Gorda, Oleksandr V. Gorbenko and Anton O. Kelemesh (figure 20) conducted a literature analysis and found that while ICT is widely used in higher education, computer programs and mobile applications are typically developed for secondary school disciplines. To address this gap, the authors developed a mobile application that includes theoretical, educational, and practical components. The application was found to improve students' success rates in laboratory work on the topic of measuring parts with a micrometer during distance learning, with a 7.3% increase in the percentage of qualitative

success compared to distance learning without the application. The paper details the process of developing the application, including modeling the micrometer in the CAD system, creating training scenes in the Unity game engine, and writing scripts to fully immerse students in the learning process. Overall, the paper highlights the potential of mobile applications in facilitating laboratory work during distance learning and provides a valuable example for educators looking to incorporate technology into their teaching practice.

The authors' related works are referenced as [53–55].

2.6. Competency-Based Education Platforms



Figure 21: Presentation of paper [115].

The COVID-19 pandemic led to a public health emergency that required the confinement of populations worldwide, including the suspension of face-to-face classes at all educational levels in the Spain. In response, educational centers and teachers turned to social media as the primary means of communication to continue teaching and socialization processes. The study “Possibilities and limitations of social media in education processes during the pandemic: The teachers perspective” [115] by Laura Joana Papanikolopoulou Arco (figure 21) aims to investigate the possibilities and limitations of social media as the sole means of communication in education, from the perspective of teachers. The methodology involves the distribution of an anonymous questionnaire to secondary education centers in the Basque Country and Navarra regions, with data collection conducted electronically. The results reveal the possibilities and limitations of digital media in teaching processes, identifying both surmountable and insurmountable challenges. Overall, this research contributes to the growing body of knowledge on the role of technology in education, with implications for future educational policy and practice.

The author' related works are referenced as [112–114].

The article titled “Modelling of AGM-style doxastic operations in three-valued setting” [72] by Nadiia P. Kozachenko (figure 22) aims to identify controversial issues and areas for further research in the theoretical approach to modeling of reasoning. The study focuses on one of the primary modeling approaches based on the AGM concept of belief revision, which is considered classical due to its foundational concepts of belief, representation, cognitive actions, and construction of epistemic systems. However, several controversial issues, such as the purity and primacy of doxastic operations and their connection, need further research to address.

To address these concerns, the study proposes modeling the AGM ideas within the framework of the consistent and complete logic of Ł3, using a three-valued logic formalism to constrain the functioning of doxastic operators. This approach will enable testing of the AGM postulates

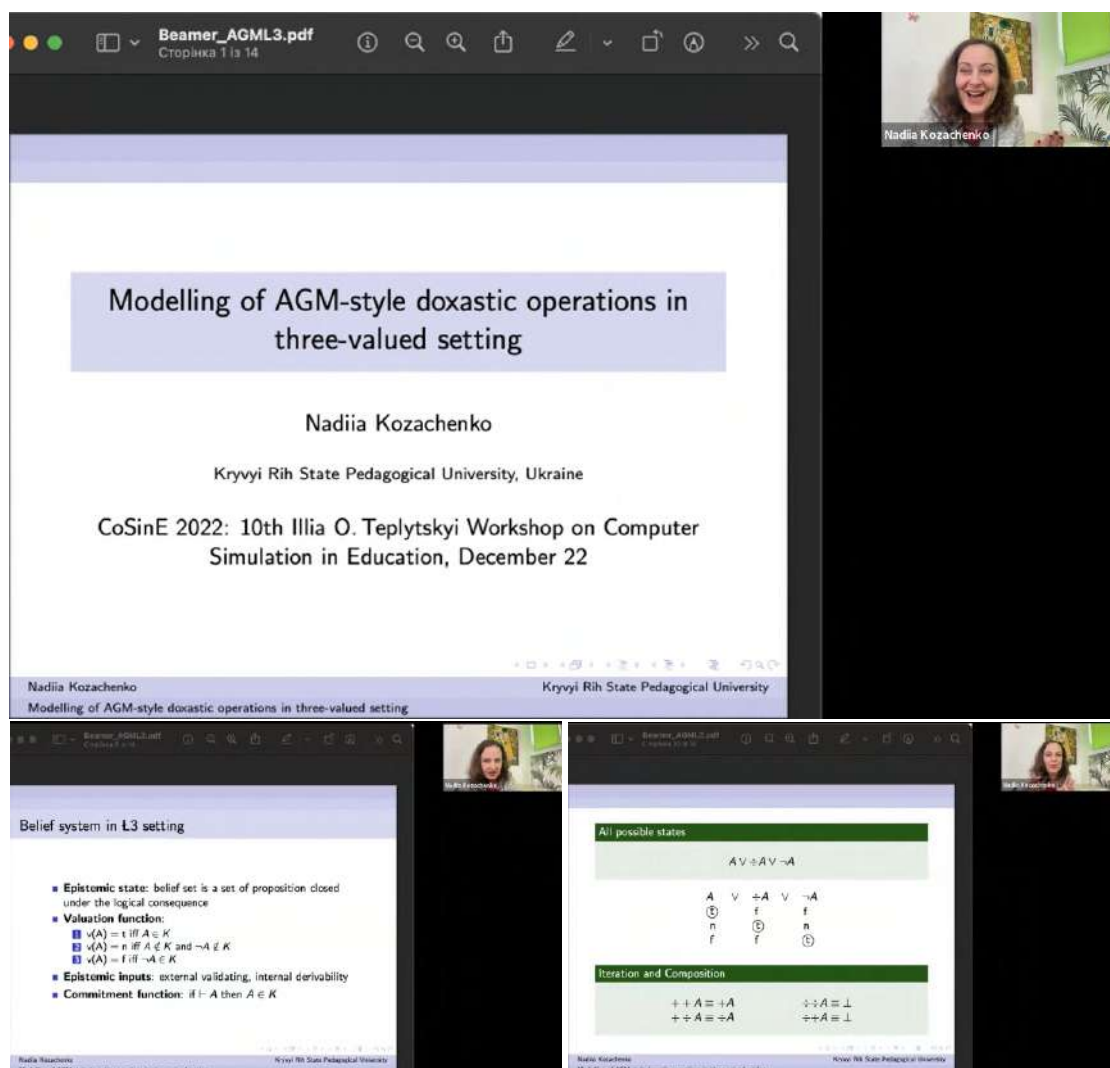


Figure 22: Presentation of paper [72].

and finding possible solutions to the classical AGM problems. The study also explores the possibility of obtaining other doxastic operators and implementing the minimality criterion for the contraction operator by combining several theorems of three-valued logic.

The proposed method of translating an informal conceptual scheme into formal logic is useful in teaching the basics of modeling and demonstrating the limitations and relationships of modeled objects and processes. Overall, the study provides insights into controversial issues in AGM-style doxastic operations and suggests potential avenues for further research. This article highlights further research by the authors, begun in [1, 2, 71].

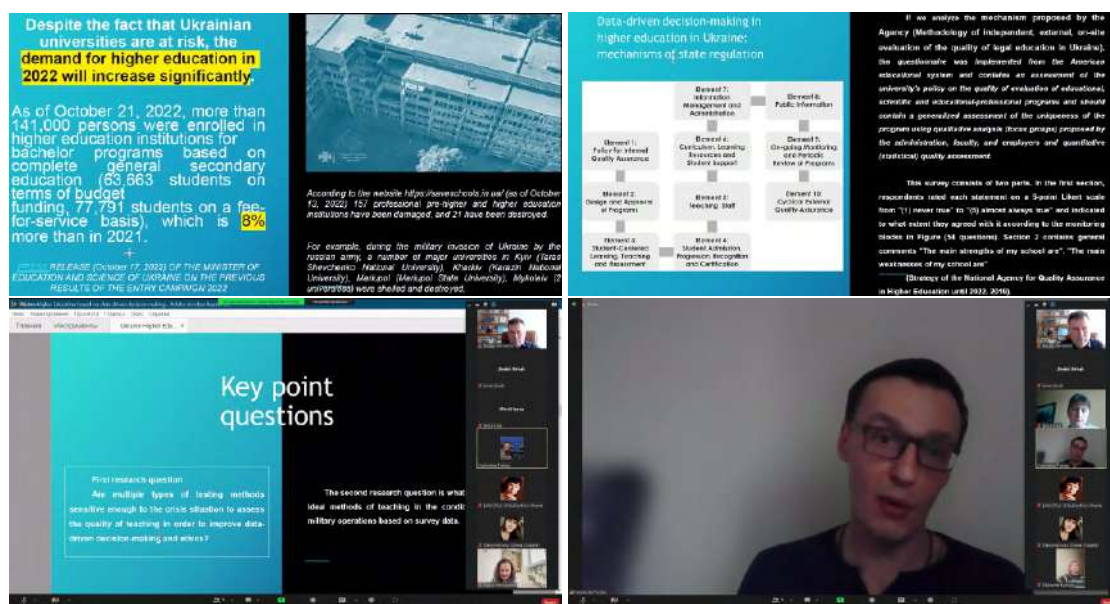


Figure 23: Presentation of paper [24].

2.7. Social Analytics in Education

The article “Ukraine Higher Education Based on Data-Driven Decision Making (DDDM)” [24] by Kateryna Bondar, Olena Shestopalova, Vita Hamaniuk, and Vyacheslav Tursky (figure 23) presents a study on the evaluation of the quality of online undergraduate and graduate education during the 2022 Russian military invasion of Ukraine. The authors conduct a qualitative theoretical analysis and empirical research, comparing higher education quality assessment data from across Ukraine during the war. They analyze the tools and structure of student feedback on the educational process and modify the programs based on the analysis of this data. The article also discusses the National Qualifications Framework, which has been under development since 2014 and requires universities to provide empirical evidence of students acquiring interdisciplinary competencies. The authors present baseline data on the assessment of online education quality during the war using the case study of Kriviy Rih State Pedagogical University. Finally, the authors propose modifications to the questionnaire for assessing the quality of teaching to enhance data-driven decision-making and testing ethics. This article builds upon the authors’ previous research [73, 125, 130].

The research “Economic analysis of factors associated with education and employment” [6] by George Abuselidze (figure 24) and Gia Zoidze aims to analyze the current state of the Georgian economy and labor market, including workforce structure, challenges, and trends, by conducting qualitative and quantitative studies. Market requirements were analyzed, and consultations were held with experts, employers, and representatives from the Center for the Development of Quality Education. The study also examined the compatibility of higher education programs with market demands, practical components in the educational process, and the relationship between higher education institutions and students. The findings suggest

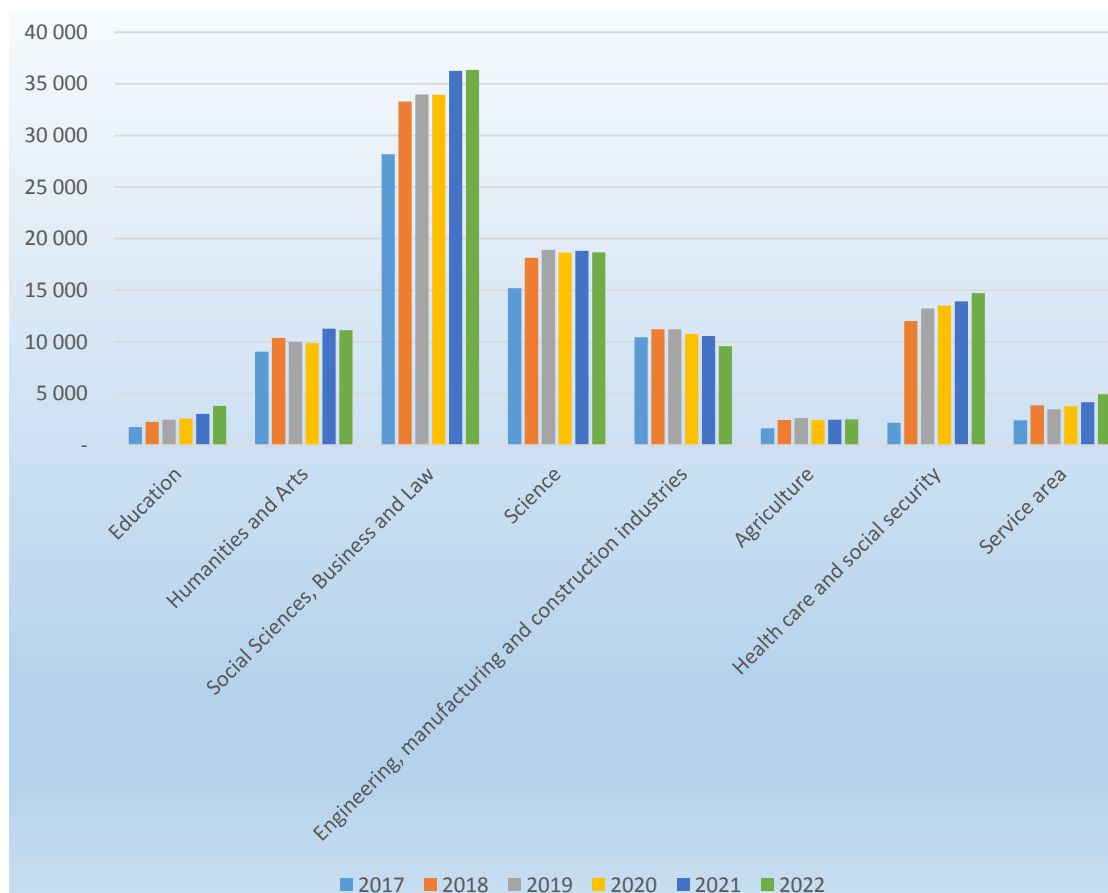


Figure 24: Presentation of paper [6].

that promoting professional education, with the proper involvement of the state, can positively impact the economy and the country's situation. Additionally, the study examined the influence of higher education on employment and income, indicating a discernible return on investment, but also highlighting that human capital developed in the higher education system is not efficiently employed. The study concludes with recommendations to address the issues facing the Georgian labor market and envision labor force demand. Overall, this research sheds light on the intersection of education and technology in addressing workforce needs in the Georgian context.

The authors' related works are referenced as [3–5].

2.8. Smart Campus Technologies

The article “Development of the information system for navigation in modern university campus” [46] by Liudmyla E. Gryzun (figure 25), Oleksandr V. Shcherbakov and Bogdan O. Bida presents algorithmic, interface, and technological solutions for developing an information system for indoor navigation in university campuses. The scientific and applied problem of indoor naviga-

CITED²⁰²² 21-22 DECEMBER 2022 / KYIV, UKRAINE
ACNS Conference on Cloud and Immersive Technologies in Education

Development of the information system for navigation in modern university campus

Professor LIUDMYLA GRYZUN,
Professor OLEKSANDR SHCHERBAKOV,
Master student BOGDAN BIDA

Information Systems Department
Simon Kuznets Kharkiv national university of economics,
Kharkiv, Ukraine

The graphic module as a set of interface elements and program code

The technological approaches to the design and development of the navigation system

- Angular as a framework for SPA web-apps development
- RxJS – library for reactive programming
- svgdotjs – library for svg processing in OOP style
- zxing/ngx-scanner – library for QR-codes scanning in real time

Figure 25: Presentation of paper [46].

tion is analyzed, and the capabilities of existing navigation systems with similar functionalities are evaluated. The study concludes that the analyzed analogues have certain limitations. The functional and non-functional requirements for the university navigation system are specified, and its architecture is defined as a set of interconnected modules, for which appropriate interface and algorithmic solutions are elaborated. The design and development stages of the university navigation system are highlighted, along with its implemented functionality. The study establishes that the main limitations inherent in similar systems implementing indoor navigation can be overcome during the design process. The results of the system implementation in a national university are discussed, and user feedback is presented. The study confirms the feasibility of developing and using an information system for navigation in university campuses. Finally, the prospects for further work in this area are discussed.

The authors' related works are referenced as [19, 20, 23].

The article “An IoT system based on open APIs and geolocation for human health data analysis” [65] by Oksana V. Klochko, Vasyl M. Fedorets (figure 26), Maksym V. Mazur and Yurii P. Liulko was the only paper accepted for presentation at CSTOE 2022. The authors highlight the growing popularity of open API-based applications, which offer new opportunities for real-time monitoring of human health using IoT, AI, and cloud computing technologies. The study describes the development of an application that uses smart gadgets and meteorological

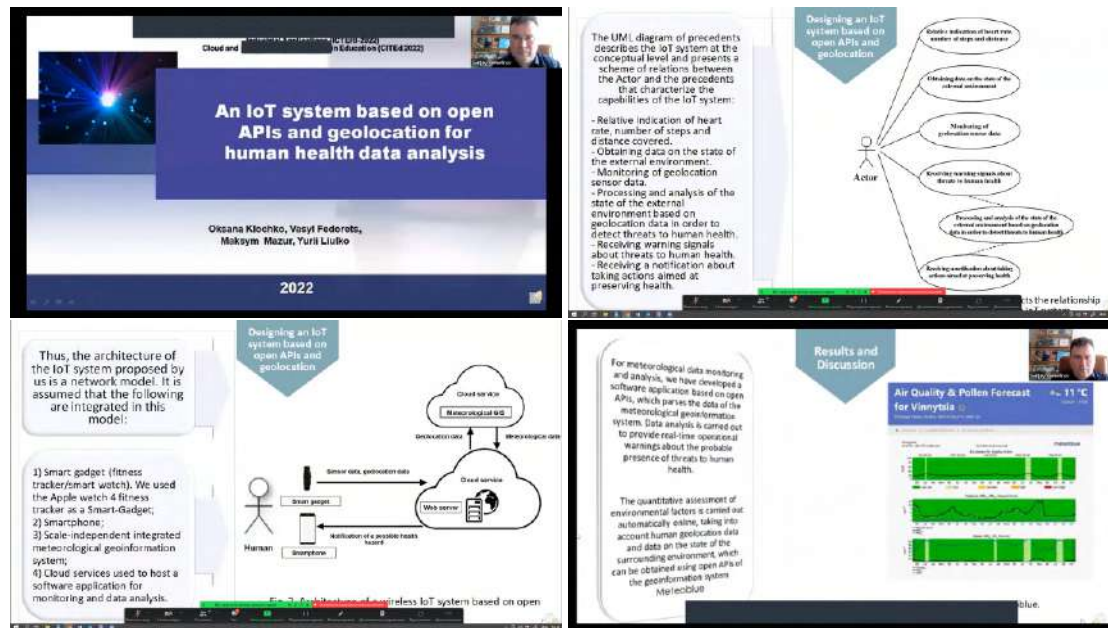


Figure 26: Presentation of paper [65].

geographic information to generate alerts about potential health risks, such as high pollen concentrations or poor air quality. The authors believe that this application has significant potential to improve healthcare efficiency in extreme or sustainable conditions, particularly during and after the COVID-19 pandemic. They suggest that further research in this area could involve data processing in healthcare systems using machine learning and deep learning, and that the developed IoT system could also be used for educational and scientific purposes. The authors' related works are referenced as [64, 66, 151].

The article "Smart education in the prospective teachers' training" [37] by Natalia Ye. Dmitrenko, Oksana V. Voloshyna, Svitlana S. Kizim (figure 27), Kateryna V. Mnyshenko and Svitlana V. Nahorniak explores the concept of smart education and its potential for developing the professional training of future teachers. The main components of smart education, including smart students, smart pedagogy, and smart environments, are examined, and the principles underlying this approach to education, such as mobile access and the creation of new knowledge, are defined. The features of smart education are also discussed, with a focus on its implementation in the context of the COVID-19 pandemic and military events in Ukraine. The study identifies the functions of the smart system in the pedagogical cycle, including its content, technological components, and facilities for students and teachers. The criteria for evaluating smart complexes, such as automation, sequencing, assessment, data collection, and self-organization, are identified. The study also examines distance learning systems for creating smart complexes in the training of prospective teachers, drawing on student surveys to evaluate the advantages and disadvantages of using smart technologies in the educational process. Finally, the article outlines avenues for further research on the integration of smart education into teacher training programs. Overall, this research contributes to the literature on education science by high-

**Smart Education
in the Prospective Teachers'
Training**

Natalia Dmitrenko, Oksana Voloshyna, Svitlana Kizim,
Kateryna Mnyshenko, Svitlana Nahorniak

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Vinnytsia, 21001, Ukraine
Vinnytsia Cooperative Institute, 59 Akademika Yanhela Str., Vinnytsia, 21009, Ukraine

The main elements of this system:

- a smart student,
- a smart pedagogy,
- a smart environment.

The smart learning environment is considered as a technology-oriented learning environment that support the quick adaption of the entire educational process and proper interaction between learners and the environment in a sophisticated manner. The smart environment includes space, place, time, technology, devices, control and interaction.

The main principles of smart complexes:

Criteria of a smart complex:

- 1 automation;
- 2 sequencing;
- 3 assessment;
- 4 data collection in real time;
- 5 self-organization.

The main principles of smart complexes:

- 1 ensuring compatibility between the software of different operating systems;
- 2 mobility, continuity and free access to any information;
- 3 autonomy of the teacher and student;
- 4 definition and application of various motivational models;
- 5 assessment of changes and competence;
- 6 change of education due to individual capabilities and interests of the student.

Distance learning systems for creating smart complexes: Moodle, Google Classroom, iSpring Online, and Edmodo.

Figure 27: Presentation of paper [37].

lighting the potential of smart education for enhancing the professional development of future teachers.

The authors' related works are referenced as [36, 47, 120].

3. Conclusion

The Academy of Cognitive and Natural Sciences, in partnership with the Institute for Digitalisation of Education of the NAES of Ukraine, Kryvyi Rih State Pedagogical University, Kryvyi Rih National University, Ben-Gurion University of the Negev, and Zhytomyr Polytechnic State University, had the pleasure of hosting the ACNS Conference on Cloud and Immersive Technologies in Education (CITED 2022).

We extend our sincere gratitude to the authors who submitted their papers and the delegates for their active participation and unwavering interest in the conference, which have provided

a platform for the exchange of ideas and innovation. Our heartfelt appreciation goes to the program committee members for their continuous guidance and to the peer reviewers whose diligent efforts have substantially enhanced the quality of the papers by providing constructive criticisms, improvements, and corrections. We acknowledge and thank the authors for their significant contributions to the success of the conference.

Furthermore, we express our deepest appreciation to the developers and other professional staff of the *Academy of Cognitive and Natural Sciences* (<https://acnsci.org>) and *Not So Easy Science Education* platform (<https://notso.easyscience.education>) for providing us with an excellent and comprehensive conference management system that has facilitated every aspect of the conference's organization, from the call for papers and reviewer invitations to paper submissions, author communications, and beyond.

We anticipate excellent presentations and fruitful discussions that will broaden our professional horizons, and we trust that all participants will derive immense satisfaction from the conference. We look forward to the day when we will be able to meet again in person under more tranquil and peaceful circumstances.

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