

Digital Technologies and Education of the Future

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Abstract. It is not the first year in the educational environment that there has been a tendency for students to have a better command of modern technologies than their parents and teachers. The constant use of various digital technologies in the process of growing up by the iGen generation to implement or simplify various life processes leads to the fact that the absence or insufficiency of their use in the educational process makes classes less interesting and comfortable than for previous generations of students. The issues of digital transformation of universities, rethinking of their main processes, the use of a pool of modern technologies as a tool for involving a modern student in the lifelong learning process are increasingly being raised. This article presents the results of bibliometric mapping on selected keywords related to digital learning, and discusses technologies that can accelerate the transition to smart learning. The results of an online survey of students concerning the level of students' awareness of learning opportunities in the virtual world are demonstrated, the project of creating objects and scenarios for educational activity of a master class in the metaverse is illustrated.

1 Introduction

In accordance with the Sustainable Development Goal "Quality Education", it is necessary to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" [1]. Access to quality education is impossible without the use of modern digital technologies that can ensure the "globalization" and "virtualization" of learning. In addition to access to the most modern educational resources from anywhere in the world, global communication and the replacement of a real person with a digital avatar provides additional opportunities regarding the inclusiveness of the learning process, the realization of the possibility of obtaining individual experience, the safety of the process of applying theoretical knowledge in practice.

In general, it is already safe to say that education is increasingly moving to a convenient online format, which gives the actors of the educational process the opportunity to interact from anywhere in the world, but at the same time there is a danger of losing contact with students, losing the effect of presence and involvement, as well as reducing the motivation and involvement of students. Phrases about the superficiality of students' knowledge, the desire to "quickly and easily (without making an effort and without looking for suitable methods)" mastering new knowledge, which is then forgotten and not used, difficulties in

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concentrating on one process for a long time, are increasingly heard at international forums and conferences. How can I improve the efficiency of working with students in this format? The answer to this question is a visual learning roadmap, seamless transitions, a variety of learning formats, an attractive learning experience (exciting programs and interesting experts), adaptability of learning, application of skills to solve real problems, timely support of students throughout their studies, a strong community in which each student is a team member. Considering the issue of student engagement and motivation as one of the important problems of future education, we turned to the results of the annual Gartner study [2]. In 2022, experts identified the following promising technologies within the framework of two topics – "learning environment" and "learning and engagement": metaverse, quantum computing, immersive technologies, artificial intelligence, digital assistants, adaptive learning systems, educational analytics, "hyflex classroom", chatbots, 5G, smart campus, digital learning platforms, emotional intelligence, let's say the long-term trend will be metaverse and quantum computing. This article presents the results of mapping (building a bibliometric map of publications on the topics of "Educational ecosystems" and "Digital Education") and primary visual cluster analysis using the VOSviewer software, into which data from 468 (selected from 5,357 initially found) publications were loaded. The "co-occurrence" method was chosen, which clusters keywords according to the degree of how often they occur together in one work. As a result, keywords form thematic clusters, the size of a word is determined by the strength of its connection with other words, and arcs reflect the connections between two separate keywords. As a result, several clusters were identified: decision making, learning systems, students, high education, AI, ecosystems, educational environment. For the higher education cluster, there is a clear relationship with promising modern technologies (virtual reality, blockchain, Internet of things, artificial intelligence, cloud technologies, etc.), mobile learning, training analytics and sustainable development goals (Fig. 1). Comparing the results of the bibliometric analysis with the results of the Gartner study, we can conclude that there is a significant coincidence of technologies.

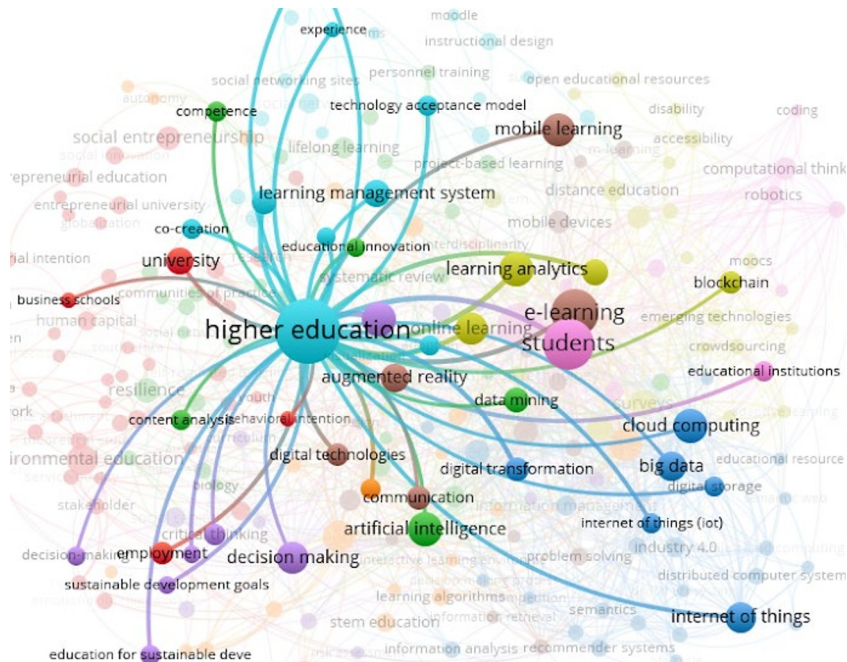


Fig. 1. Graph of interaction of key terms in the cluster "higher education".

2 Materials and Method

In article are used bibliometrics tools such as VOSviewer ("co-occurrence" method) that shows the hottest topics in scientific community; online survey with first- and fourth-year students in order to find out how realistic it is now to make the learning process hybrid. BPMN diagrams are used to visualize scenarios for conducting of educational activities. Modeling, texturing and optimization techniques are used to create 3D objects (avatars).

3 Results and Discussion

3.1 Information technologies for "smart" education

Progress in the field of ICT, the speed of the emergence of new technological startups, as well as comprehensive intelligent educational solutions provided by well-known global suppliers of ICT solutions, contribute to closer interaction between the educator and students, despite the large geographical distances in reality. In the modern education system, many intelligent devices have appeared, adapted to intelligent learning systems and personalized e-learning systems. Students can use smart devices to perform current tasks, conduct research and communicate with other students (including virtual ones). The teacher can use intelligent devices to monitor students, check their work, simplify verification and make the assessment system more transparent. The applications used allow you to provide feedback to the teacher at any time and in any place. The concept of Smart education is currently a popular concept of learning in the digital age, it is defined by different researchers in different ways. It is based on the emphasis on the features of the educational process, the environment, intelligent technologies, a system aimed at acquiring the necessary competencies, etc. According to Kanvar [3], smart education should be: delivering pleasant emotions, so that the student strives for maximum preservation and transfer of the acquired knowledge into long-term memory; attractive due to innovative application of technologies; effective in terms of the availability of the most relevant and modern resources and in terms of the development of a responsible citizen capable of being competitive in the labor market, ethical in relation to confidentiality, cybersecurity and adequacy of assessment. The learning environment in the smart education model shows the inextricable link between online, offline, formal and informal learning. It should focus on creating a continuous and individual digital learning space for students who can choose suitable and convenient learning terminals depending on the situation. Regardless of the proposed definition, one of the key characteristics of the concept under consideration is information technology. Let's consider some of the main information technologies that provide "smart" education (Table 1) [4]. The prospects and rapid spread of metaverses can be observed right now. Initially spread as part of gamification, metaverses have now become marketplaces where clothes, furniture, books are sold, as well as spaces for modern exhibitions and installations where paintings and other art objects are exhibited. For several years in the field of business in the metaverse, large companies have been holding forums, meetings and conferences. Metaverses are already changing many areas of society, including education. This term was nominated in 2022 for the "word of the year" by the Oxford English Dictionary, taking second place. They are virtual worlds in which people interact through avatars and digital assets.

Table 1. Information technologies for "smart" education.

Name of the technology	Definition
Metaverses (Virtual Class)	educational environments where teachers and students meet virtually.

Smart class	physical educational environments supported by information and communication technologies. Smart classrooms can use ambient intelligence technology.
Augmented Reality	a term referring to all real and virtual combined (immersive) environments in the spectrum, including augmented reality (AR), virtual reality (VR) and mixed reality (MR).
LMS (LCMS)	software applications or systems designed to create, communicate, manage and implement training and learning programs.
Web 2.0 и Web 3.0	Web2.0 — is the second generation of Internet network services that allow users to create online and use information resources. Web3.0 — is the main direction of the development of the Internet, while the idea implies that control over data is transferred from technology corporations to each individual individually.
Educational resources	any kind of educational and training materials, including educational presentations, e-books, interactive books, academic and corporate videos, etc.
Academic and corporate channels	online video sharing platforms for education.
Social network	electronic online platforms that provide social interactions between users with profiles
Educational and academic analytics	learning analytics is related to the collection, measurement and analysis of data on learning activities. Academic analytics uses business intelligence tools and strategies to make decisions in the field of education.
Cloud/Fog/Boundary computing	cloud computing — is a technology that allows you to store and process data remotely in the "cloud"; fog computing — is a technology that allows you to process data in close proximity to the sources of their receipt; edge computing — is a technology for processing and storing data on a finite device. They are even closer to the user than the "cloud" and "fog".
Educational data mining	analysis of data obtained from the educational environment to understand student behavior patterns and improve learning conditions.
Educational Robots	robots used for educational and training purposes.
Interactive training materials	digital books supplemented with the ability to interact with the user.
Gamification	the introduction of game forms in a non-game context.

3.2 The future of education and metaverses

WEB 3.0 research and in particular metaverses have been studied from different perspectives [5-14]. As technology advances, virtual learning spaces are becoming more immersive and technically accessible, changing the way students and teachers learn. Such practical classes contribute to the active participation of each student and a deeper understanding of the subject being studied, as well as make the learning process more exciting, effective and unusual. The research results of foreign and domestic researchers and developers in the field of WEB 3.0 and metaverses are theoretical in nature and help in the study and understanding of the metaverse structure, its architecture, methods of application, related technologies of tools, as well as ways of interacting with it. Within the framework of this study, an analysis was carried out, the results of which show how much students are currently aware of the possibilities of conducting activities in the metaverse, and also illustrated the project of creating objects and scenarios for educational activity, a master class on the topic "Developing a business idea" in the OnCyber metaverse.

Metaverses have been used for a long time for various fields of activity. Conventionally, the list of such areas can be divided into two categories. The first is the use of the metaverse as a tool (education, healthcare, office work), the second assumes that the metaverse is more of a goal than a tool (the sphere of gaming technologies, the sale of virtual space, etc.). Modern metaverses provide companies and educational institutions with tools for fruitful work, such as: support for cameras, microphones and virtual avatars, as well as full integration of text editors and tables. In addition to virtual worlds, platforms provide built-in support for the output of media and documents, as well as a number of activities that will help you relax. Metaverse platforms in education provide students with the opportunity to exchange virtual spaces, methods and content, which contributes to their academic and personal development. Moreover, the metaverse is the basis for changing the classical model of education, which is traditionally static, to a dynamic model, mobilizing a wide range of situations, methods, tools, as well as forms of learning and assessment and placing the student at the center of the educational process, which potentially increases their motivation to learn.

Already at this stage of development, metaverses are able to support modern neural network standards, which makes it possible to create separate worlds dedicated to educational goals. For example, disciplines such as history or chemistry may not be of interest to everyone, and such a platform in the hands of an educational organization would solve this problem by implementing scenarios in its virtual audience devoted to the origin of chemical elements or famous battles, while increasing interest in such kind of events through the introduction of interactive objects, when interacting with by which a neural network embedded in the metaverse would generate brief information about it. In addition, the technology in question would gain great popularity in teaching life-threatening or technically complex equipment-related professions. The metaverse architecture represents elements of a decentralized platform, thanks to which a high degree of compatibility can be achieved to ensure the mobility of digital identification data, experience and property within the framework of the platform. It is worth noting that to interact with the metaverses, the user needs to use either a computer or a tablet/smartphone. For full immersion, you need to connect virtual reality glasses with all the peripherals that come with them. If full immersion is not critical for the user, you can neglect this gadget, because the functionality provided to the user of the platform does not change significantly from this.

In order to find out how realistic it is now to make the learning process hybrid, in the period from November 2022 to April 2023, we conducted an online survey of 292 first and fourth year students (Faculty of Business and Faculty of Humanities), the purpose of which is to identify the preferences and level of awareness of students in this field. The survey consists of fifteen open and closed questions that determine students' preferences in the field of metaverses and provides a function of logical branching depending on the answers to certain questions. Table 2 shows a fragment of the results of the survey "Analysis of the level of awareness of students about the possibilities of conducting activities in the metaverse" (Table 2).

Table 2. Summary results of the survey "Analysis of the level of awareness of students about the possibilities of conducting activities in the metaverse" (fragment).

Question	The most popular answer	
	Male	Female
Are you familiar with the concept of a "metaverse"	Yes, but I haven't used it in practice	No, but I would like to know about it
What do you mean by a metaverse	A digital platform that combines many services	

Which metaverses have you interacted with?	VRChat	
Positive aspects of metaverses	The possibility of remote user interaction	The possibility of remote user interaction
	Availability of opportunities to create and interact with any object that does not exist in reality	The ability to interact with a large number of users
Negative aspects of metaverses	The need for additional equipment	Low mobility while working in the metaverse
Are you interested in a hybrid learning format using metaverses?	Yes	
What educational activities using metaverses would you like to participate in?	practical classes / master-class	master-class
Which avatar would you choose for the metaverse?	a character in a famous franchise	Himself in a digital representation/ a character of a bygone era
What form of interaction with other participants is most interesting to you in the metaverse?	Creation/participation in training scenarios and Game activity	Creation/participation in training scenarios and interactive exhibitions
What is the maximum number of people for you when interacting in the metaverse?	280	119

Based on the analysis of the survey results, it can be concluded that about half of the respondents (currently studying at a higher school) are familiar with metaverses and an even smaller part have interacted with them. The most popular among the respondents are gaming metaverses, which are aimed at entertainment and leisure, and not at creating a favorable working environment. The possibility of remote interaction with other users, noted by students, is particularly relevant both from the point of view of the implementation of the Sustainable Development Goals (virtual spaces make possible equal access to high-quality education, the possibility of communication with teachers from different countries, the use of theoretical information in practice without real harm to health), and the prospects for the transition of training to online during the pandemics. The most interesting are the answers to questions directly related to the respondents' interest in a hybrid form of learning using metaverses. The vast majority are interested in this format of teaching academic disciplines, especially when it comes to conducting master classes and practical classes. From the point of view of equipment costs, there is also no need to worry, because almost half of the respondents have enough computer or phone for comfortable work. Since the master classes received the majority of votes according to the results of the above survey, the creation of objects and scenarios for educational activity was chosen as a project - a master class on the topic "Development of a business idea" in the OnCyber metaverse. For events in the metaverse, the following parameters are set, under which the interaction within the virtual space will be as smooth and comfortable as possible: the duration of the event is from 45 to 90 minutes, and if the duration is close to the upper limit, it is advisable to take at least one five-minute break; the average number of users is 15-20 people; the number of objects in the

space (depends solely on the characteristics of the equipment) – it is not recommended to exceed the number of 40 units, as this may affect the performance and initial loading of objects when entering the space. The structure of the scenario "Master-class on developing a business idea" from the student's perspective is shown in the figure 2 as a diagram in BPMN 2.0 notation.

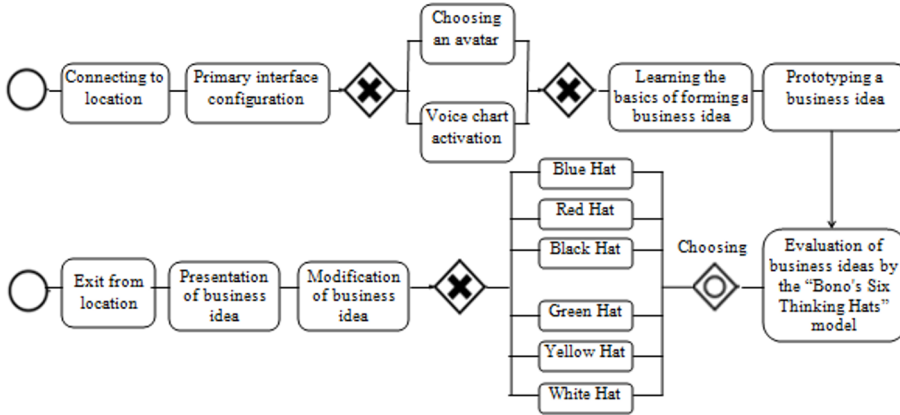


Fig. 2. The structure of the scenario "Master class on the development of a business idea" from the position of a student".

The figure 3 shows an enlarged algorithm for the development of objects and scenarios for an educational event in the metaverse. The virtual gallery has its own zone, in which 3D objects and other materials are located: six hats (for analyzing selected business ideas); paintings with training materials - diagrams with definitions of concepts and rules for calculating indicators when developing a business idea, as well as training videos; a workplace consisting of a table and four chairs.

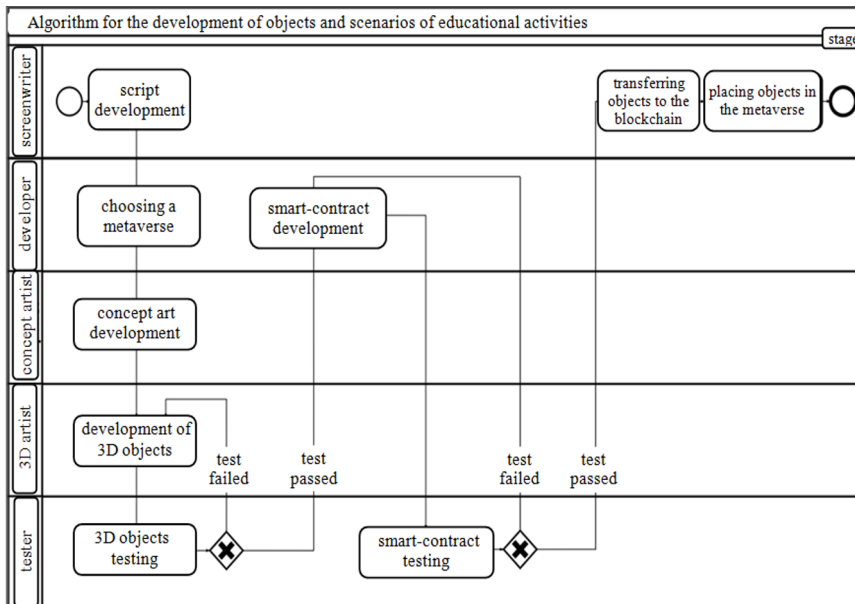


Fig. 3. Algorithm for the development of objects and scenarios of educational activities in BPMN 2.0 notation.

A smart contract has been written for placing objects on the Ethereum blockchain and further working with them in the OnCyber metaverse (Fig.4). At the time of writing, the scenario of the master class was implemented in a pilot mode for a group of fourth-year students of the Business Informatics direction. The duration of the master class was approximately 45 minutes. Feedback from these participants of the master class showed that students who often play computer games easily got involved in the communication process, got acquainted with the materials presented in the virtual space on the wall on the left and completed the tasks, however, the part of students who were not used to virtual gaming was guided more slowly than on the usual similar face-to-face at the University, after the end of the lesson, I felt very tired. However, the "unusual" format of the lesson has an effect in the form of generating interesting ideas within the framework of the proposed topic, as well as the desire to continue studying in a similar format for all students participating in the experiment. Although education using metaverses is still at an early stage of its development, its potential for transforming the educational environment is quite high. As technologies develop and become cheaper, we should expect the appearance of virtual study places available to any student. Thanks to the achievements in the field of artificial intelligence, blockchain, augmented reality, the implementation of global virtual spaces, individual experience, inclusive learning with a "WOW" effect will be ensured.



Fig 4. The space for the scenario "Master class on the development of a business idea" after filling with objects.

4 Conclusions

In conclusion, we will discuss the problem associated with the actively discussed "uberization" of education. On the one hand, it is really a concept directly related to the digital (sharing) economy and, of course, has its own positive connotation associated with the implementation of the task of "personalization" of educational services. "Uberization allows using modern IT technologies to minimize the number of links between the service provider and the consumer. Builds a clear and transparent process where the user can control the transaction and evaluate the quality of services"[15]. That is, in relation to the education system, through digital platforms, upon request and certain criteria of the student, teacher options will be automatically found (and in more advanced versions, educational institutions and courses) that will be able to provide the necessary service on demand. Such peer-to-peer transactions will allow you to save on transaction costs and find a mentor for a student from anywhere in the world, make the process of obtaining knowledge from the student controlled – when to start and when to finish – and in case of compliance with the rules of digital security and the implementation of a smart contract, it will certainly be beneficial to both sides of the process. For teachers, uber platforms can become a platform for advertising their skills and

abilities, the ability to independently set prices for their services and offer students their own unique content, in addition, it will be possible to choose students from the pool of those who want to receive the service. At the same time, another problem is solved – the search and verification of the reliability of potential consumers of services and the guarantee of their timely payment. However, questions remain open related to who and in what form will evaluate the quality of teaching and the quality of mastering knowledge and skills, i.e. conduct an independent examination. Won't such an important aspect of student-teacher interaction as personal communication and emotions, as well as group interaction and collegial decision-making and compromise be lost? Finally, such a format of digital education is closely related to artificial intelligence and will it not turn out in the future that living unique lecturers will be replaced by digital influencers, which will be generated by artificial general intelligence, which will independently decide what skills to teach real people.

References

1. Sustainable Development Goals. United Nations Organization (2015)
2. R. Yanckello, Hype Cycle for Higher Education (2022)
3. A. Kanwar, Smart education for the future. Keynote presentation at Global Smart Education Conference (2021)
4. K. A. Demir, Smart Learn. Environ, **8**, 29 (2021)
5. T. Yerlikaya, Prizren Social Science Journal, **6(3)**, 55-63 (2022)
6. B. Mohanta, S. Panda, D. Jena, 9th ICCNT (2018)
7. B. Zhou, Mobile Information Systems, **3** (2022)
8. H. Gwo-Jen, C. Shu-Yun, Computers and Education: Artificial Intelligence, **3** (2022)
9. X. Zhang., Y. Chen, L. Hu, Y. Wang, Front. Psychol., Sec. Educational Psychology, **13** (2022)
10. Ch. Zabel, D. O'Brien, J. Natzel, Technological Forecasting and Social Change, **192** (2023)
11. G. Wood, Ethereum Project Yellow Paper, **151**, 1-32 (2014)
12. F. Russell, M/S J., **25(2)** (2022)
13. S. Park, S. Kim, Sustainability, **14(3)** (2022)
14. L. Liu, S. Zhou, H. Huang, Z. Zheng, IEEE Open Journal of the Computer Society, **2**, 204-215 (2021)
15. A. Akhmetov, Blog Architects of Russia (2020)