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Digital Learning Environment in the Modern Process of Education and Upbringing

Цифровая образовательная среда в современном процессе обучения и воспитания

Study of the Educational Process Participants Readiness to Applying Digital Technologies in Education

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The article presents an overview of various digital technologies used in the educational process; the problem of their perception and application by teachers and students is investigated. The purpose of the article is to identify the level of readiness of direct participants of the educational process to use digital technologies in their activities. The study was conducted on the basis of analysis and generalization of domestic and foreign scientific publications devoted to the problem of the use of digital technologies by participants of educational institutions. A sociological study was conducted by online questionnaire of students. The research methods are comparison, concretization, system and comparative analysis. The authors have revealed that the teachers' perception of the use of digital educational technologies in their activities depends on various factors, such as: age, gender, availability and degree of development of organizational and communicative abilities of a person, on the degree of motivation, as well as on the level of creativity of the teacher's personality. It is revealed that there are various barriers to the use of TSOT by teachers. Regarding the readiness of students to use TSC, it was found that students are not fully ready to use TSC in teaching, in particular, they are not aware of the essence of the concept of immersive technologies and do not identify them with virtual or augmented reality technologies. A significant part of students uses digital services that are quite similar in functionality. The actual digital technologies used in teaching in the world practice are revealed. The necessity of using digital services in virtual educational environments, including metaverses, is substantiated. In order to increase the ability of teachers to use TSOT, it is necessary that the curricula include courses on the use of TSOT in education in the context of vocational training. It is also proposed to encourage teachers to use technology in the educational process by allocating additional funding. Universities need to create conditions for students to use digital technologies.

Keywords: digital educational technologies; educational process; immersive technologies; virtual or augmented reality; metaverses; readiness of teachers; students' readiness.

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Исследование готовности участников образовательного процесса к применению цифровых технологий в образовании

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В статье представлен обзор различных цифровых технологий, используемых в образовательном процессе; исследована проблема их восприятия и применения преподавателями и студентами. Цель статьи — выявить уровень готовности непосредственных участников образовательного процесса к применению цифровых технологий в своей деятельности. Исследование проводилось на основе анализа и обобщения отечественных и зарубежных научных публикаций, посвященных проблеме применения цифровых технологий участниками образовательных учреждений. Проведено социологическое исследование путем онлайн-анкетирования обучающихся. Методами исследования являются сопоставление, конкретизация, системный и сравнительно-сопоставительный анализ. Авторы выявили, что восприятие преподавателями применения в своей деятельности цифровых образовательных технологий (ЦОТ) зависит от различных факторов, таких как: возраст, пол, наличие и степень развитости организаторских и коммуникативных способностей человека, степень мотивации, уровень креативности личности педагога. Выявлено, что существуют различные барьеры по использованию ЦОТ преподавателями. Относительно готовности студентов к применению ЦОТ обнаружено, что обучающиеся не в полной мере готовы к применению ЦОТ в обучении, в частности, они не осведомлены о сущности понятия «иммерсивные технологии» и не идентифицируют их с технологиями виртуальной или дополненной реальности. Значительная часть студентов используют довольно схожие по функционалу цифровые сервисы. Выявлены актуальные цифровые технологии, используемые в обучении в мировой практике. Обоснована необходимость применения цифровых сервисов

в виртуальных образовательных средах, в том числе в метавселенных. Для повышения способности использования преподавателями ЦОТ необходимо, чтобы в учебные планы включили курсы по применению ЦОТ в образовании в контексте профессиональной подготовки. Также предлагается стимулировать преподавателей к применению технологии в образовательном процессе путем выделения дополнительного финансирования. Университетам необходимо создавать условия по использованию студентами цифровых технологий.

Ключевые слова: цифровые образовательные технологии; образовательный процесс; иммерсивные технологии; виртуальная и дополненная реальность; метавселенные; готовность педагогов; готовность студентов.

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Introduction

Due to significant changes in the volume of generated knowledge and its transfer system (annually “5% of theoretical and 20% of professional knowledge is updated” [1]), the state, teachers, students and employers have to adapt to these changes. In accordance with the “Kronberg Declaration on the Future of Knowledge Acquisition and Transfer Processes”, the main role[1] is given to online technologies. The usage of digital educational technologies (DET) at the current stage of development of the world educational system is increasing every year. The pandemic and the need for rapid adaptation to new conditions have accelerated the process of DET dissemination at the global level[2] [2; 3].

Some technologies are in high demand, while others are still developing more slowly for economic or technical reasons. In recent years, the alternative market of educational technologies and products, which is more large-scale and customer-oriented, first of all, has been rapidly developing. In some niches, private organizations have already become leaders in terms of the amount of money earned and have surpassed traditional universities and business schools.

Transformation of the educational process in private organizations is much faster, they apply new approaches to the educational process: classes are conducted by well-known personalities, instead of traditional lectures they use a show involving practitioners and technical specialists (sound engineers, cameramen, assistants, etc.), they do recording and public broadcasting, use interactive approaches and gamification using a feedback from the audience, they create exciting educational content using wide range of educational methods, virtual reality and augmented

[1] Kronberg Declaration on the Future of Knowledge Acquisition and Sharing / Orenburg regional branch of interregional non-governmental organization UNESCO “Information for All” (translation) , 2007 [Electronic resource]. Access mode: http://ifap.ru /ofdocs/rest/kronberg.pdf

[2] Viatkina G.Ya. Application of innovative educational technologies as a necessary condition for improving the quality of education // Problems of modern agricultural science. Krasnoyarsk: Krasnoyarsk State Agrarian University — 2020. pp. 416—420. https://www.elibrary.ru/item.asp?id=44126151 (access date: 10.01.2023).URL: https://www.elibrary.ru/item.asp?id=44126151 (дата обращения: 10.01.2023).

reality technologies[3,4] [4—6], Such approaches cannot be economically justified in private universities with small amount of students, it requires a wider audience.

At the same time, the best educational programs of traditional universities are gradually beginning to yield to private EdTech companies in terms of the quality of content delivery. Only a few factors keep public universities from falling behind in terms of the number of students and graduates: the availability of budget-funded education, the availability of dormitories and a sports complex, obtaining a state diploma, historically established stereotypes about the necessity of higher education (in a university), and the lack of financial resources among the population. The *introduction of innovations* in the traditional educational process on open resources is more rapid than it is done by the leading universities and the most progressive teachers within classical educational institutions. The improving the educational process is most often limited by the personality of leaders of the educational organization and the quality of the teaching staff.

There are quite a few examples of systemic development at the Russian national and regional levels, it's not enough to modify educational system to modern conditions.

In Russia, as a positive example, we can name such initiatives as grant support for teachers to create high-quality electronic content, including the use of VR technologies (supported by the Moscow Government). At the same time, teachers from all over the country and legal entities can create content, which is open to all users of the regional library complex.

The website open.edu has become extremely popular, especially during the pandemic period, as it hosts educational courses from many universities, giving students all over Russia the opportunity to get additional knowledge in areas of their interest. However, this resource needs support in promoting and updating its content. Educational institutions face a new challenge to create an attractive and practice-oriented educational product at a new level. The basis for this transformation should be new digital educational technologies, as modernization of education is aimed not only at updating the content of disciplines, but also at applying new educational methods and techniques, increasing the involvement, interest and motivation of students[5, 6, 7, 8, 9, 10, 11].

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[3] Shmelev, R.V. Web quest as a modern educational technology / R. V. Shmelev // Challenges of modern education in the research of young scientists. Krasnoyarsk: Krasnoyarsk State Pedagogical University named after. V.P. Astafyev. — 2021. — pp. 126—128. https://www.elibrary.ru/item.asp?id=46135832 (access date: 10.01.2023)

[4] Karnilov Yu.V. Immersive approach in education // Azimuth of scientific research: pedagogy and psychology. — 2019. — volume 8. — №1 (26). — pp. 174—178. Access mode: https://www.elibrary.ru/item.asp?id= 37130026

[5] Hattie John A.S. Visible learning. A synthesis of the results of more than 50,000 studies covering more than 80 million schoolchildren. Moscow: National Education, — 2017. 496 p. Access mode: https://visible-learning.org/hattie-ranking-nfluences-effect-sizes-learning-achievement

[6] Loshkareva E. et al. Skills of the future. What you need to know and be able to do in a new complex world / Loshkareva E., Luksha P., Ninenko I. Moscow: Report, 2017. 93 c. Access mode https://futuref.org/futureskills_ru (access date: 10.01.2023).

[7] Beerda Joris. High ROI Gamification: the Octalysis User Experience Phases and Player Types// Octalysis categories icon Gamification. URL: https://octalysisgroup.com/de/high-roi-gamification-the-octalysis-user-experience-phases-and-player-types/

[8] Education for a complex society "Educational ecosystems for social transformation" // Report of Global Education Futures "Education for a complex world: why, what and how." Global Education Leaders' Partnership Moscow. 2018. 212 p. Access mode: http://vcht.center/wp-content/uploads/2019/06/ Obrazovanie-dlya-slozhnogo-obshhestva.pdf (access date: 10.01.2023).

The increasing information saturation of the educational environment requires the use of learning tools that correspond to modern conditions [7], the availability of educational resources, educational and outreach programs to improve the effectiveness of learning, increase interest in learning, the ability to build a more rational learning process [8].

Some Russian universities, for example, ITMO University, give students the opportunity to prepare and implement educational courses on a competitive basis and with the support of mentors. If we compare this experience with global educational practices, such initiatives were implemented in the USA at Indiana University more than 50 years ago in the early 1970s, where students could take their own course if they received support from one of the departments or the dean [9].

The use of innovations in education at the present stage is largely associated with the use of various digital educational technologies.

Let us define the term *digital technologies*. They are interpreted by two main aspects: the use of digitized information and all technologies that allow creating, storing, distributing and transforming data (including electronic devices, programs, etc.).

Thus, in order to determine the prospects for the development and dissemination of digital technologies in education at present, it is necessary to determine how widely digital technologies are used in the educational process.

The application of digital technologies shows that there is a wide range of them. Researchers from the Institute for Statistical Research and Knowledge Economy (ISKEE) of the Russian National Research University Higher School of Economics have compiled a rating of the most promising digital technologies, consisting of the following positions: 1. deep learning; 2. convolutional neural networks; 3. computer vision; 4. reinforcement learning; 5. natural language processing; 6. unmanned cars; 7. recurrent neural networks; 8. transfer learning; 9. generative adversarial networks; 10. decision support systems; 11. smart contracts; 12. speech recognition. 13. quantum computer; 14. federated learning; 15. autonomous robotics1. These technologies may be promising for large-scale use in the industry, which will generate demand for training specialists with competencies in these areas.

Some of the described technologies are already included in master's degree programs. The researchers of this issue identify 9 fundamental technological trends that are directly related to modern digital technologies: big data; robotics; modeling; horizontal and vertical system industrial integration; industrial Internet of Things; cybersecurity; cloud computing; additive technologies; augmented reality [10]. A number of the above-mentioned technologies are actively used in the educational market (application of big data, cloud and blockchain technologies). Big data make it possible to train neural networks and use the potential of their capabilities to improve the educational process.

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[9] Atlas of new professions 3.0. / editors D. Varlamova, D. Sudakov. M.: Alpina PRO, 2021. — 472 p. Access mode: https://atlas100.ru/upload/pdf_files/atlas.pdf (дата обращения: 10.01.2023).

[10] Egorov A.A., Zakharova U.S. and others. Digital transition: the experience of teachers and educational organizations in Russia and the world // Expert-analytical report of the Segalovich Foundation and the Institute of Education of the National Research University Higher School of Economics. 2021. — 98 p. Access mode: https://fund.yandex.ru/static/files/yandex-fund-online-edu-research-2021-v11.pdf (access date: 10.01.2023).

[11] Corporate training for the digital world. Moscow: Autonomous non-profit organization of additional professional education "Corporate University of Sberbank" , 2017. — 200 p.

A large number of sub-processes that make up the educational process can be automated: checking test assignments, submitting various applications (submission of documents, individual educational trajectory, applications, etc.), calendar planning, filling out various forms and reports, communication with students on typical recurring issues, e-tutoring, recommendation systems for participation in events, reminding about events and deadlines, educational and management analytics, attracting applicants and listeners, autonomous learning, and other processes. Many of the processes mentioned above can be improved by using RPA technologies (business process automation).

Taking into account the growth trends of the education market in general and online education and business process automation technologies, attempts are being made to automate both universities and EdTech companies. In addition to the automation of processes, the formation of metavillages as a learning environment is gaining wide development[12] prospects.

The market of educational technologies is actively developing. According to the Barometer project's open research on online education, the global education market has grown from $4.5 to $5.0 trillion in 2 years, with online education accounting for 3.5% ($175 billion). The Russian education market has grown over 5 years from 1.8 trillion rubles in 2016 to 2 trillion rubles in 2021, and the share of online education is about 2.6% (53.3 billion rubles)[13]).

The revenue of average online schools in Russia amounted to about 500 thousand rubles per month. Among the most popular directions of online courses in Russia were the following: 17% — industrial training; 13% — creativity, applied decorative skills, hobbies; 9% — sports, health; 7% — spiritual practices and personal growth; 6% — foreign languages, psychology, finance and taxes, narrow profile specializations (each category)[14].

SkyEng, one of the market leaders in online education in the Russian Federation, has already integrated neural networks and deep machine learning (artificial intelligence) into the educational process to a significant extent, adapting learning and making it more personalized, the technologies help to check assignments in real time. AI algorithms analyze video recordings of the class and track the student's progress. The neural network evaluates whether the lessons meet the quality criteria based on the laid down criteria, and at the end of the lesson gives the teacher advice on how to eliminate deficiencies, if any[15].

The postupi.online service has focused its efforts on helping university applicants to solve the problem of searching for education relevant to their interests and has automated the process of selecting universities and educational programs by profession and other specified characteristics[16].

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[12] Asako Miyasaka. Todai to offer metaverse studies to teach engineering // The Asahi Shimbun. 23 July 2022. [Electronic resource]. Access mode: https://www.asahi.com/ajw/articles/14677709 (access date: 28.11.2022).

[13] Dreval M. Research of the Russian market of online education and educational technologies: materials of the report for an international conference: Proceedings of the International Conference. 2021. Access mode: https://estars.hse.ru/mirror/pubs/share/211448255 (access date: 10.01.23)

[14] Dreval M. Research of the Russian market of online education and educational technologies: materials of the report for an international conference: Proceedings of the International Conference. 2021. Access mode: https://estars.hse.ru/mirror/pubs/share/211448255 (access date: 10.01.23)

[15] Teach a knowledgeable one: how English teachers are trained in Skyeng [Electronic resource] // SkyEng company magazine. Access mode: https://magazine.skyeng.ru/ uchi-uchenogo-kak-gotovjat-prepodavatelej-anglijskogo-vsky-eng/?ysclid=l916r05jud 749717 991. (access date 10.01.2023).

[16] See the service postupi.online for more information [Electronic resource]. Access mode: https://postupi.online/professii/ (access date 01.10.2022).

Nowadays, it is more important to help students to create their own projects and startups. The National Technology Initiative project implemented automated practices for more efficient selection of team members using AI algorithms. The developers conducted preliminary diagnostics and identified personal characteristics, values and skills in order to identify harmonious characteristics that formed the basis for the division into teams. Further work with the teams showed the success of this approach, for example, the longetivity of the developed projects were higher.

The Promobot company from Perm city published the statistics on the use of robots as teachers in the educational process all over the world. There were more than 4 thousand cases in general and 326 cases in Russia[17]. The company conducted an experiment on the use of robots in the educational process and made the robot "YURA" hold the exams for future medical doctors in the Perm State Medical University. The robot acted as a patient and checked how students made the examination according to one of the scenarios. Then the robot reported the results.

Globally, individual research groups, universities, schools and EdTech companies are experimenting with the integration of robotics into the educational process. In Germany at the University of Marburg, Professor Jürgen Handke uses a robot "Yuki" at his lectures on linguistics. Yuki gives students a task and checks the timing.

A good example of using robots as teaching assistants was realized by researchers from the University of Miami. The robot helped to conduct classes for young children doing physical exercises, teaching them using questions, children demonstrated him answers with cards that the robot could recognize [11].

Researchers are trying to find out how effective will be robots as co-learners being socialized (showing initiative in communication, taking into account individual characteristics of the person, actively moving) and non-socialized. The experiments showed that children who interacted with socialized robots had higher learning success. More than half of the children saw the robot as a friend (67%) [4]. However, the use of such technologies brings not only positive changes, but also has a risk associated with the confidentiality of data stored in robots, which can be hacked. There are also a risk of misinterpretation of answers or values transmitted by robots [12].

In some foreign universities, teachers started to implement the technology of blockchain in the preparation of students' final qualification papers. The use of the technology allowed teachers to track the dynamics of progress in the completion of final qualification papers more efficiently. Russian universities are also introducing innovations in the educational process, mastering new educational programs. Students of MIPT's Blockchain Master's program in 2022 received diplomas as non-interchangeable NFT tokens.

The smart-contract technology forms a digital smart-didactics using cloud and blockchain technologies in order to develop the education system as a whole and to promote better personal development of students. Digital smart-didactics helps teachers to better prepare the graduates, to make a personalized educational trajectory for them, to combine the educational and entrepreneurial aspects, prepare new skillful staff during a startup creation. This approach can be structered as decentral-

[17] Bunina V. The education system is over: can robots replace teachers // Gazeta.ru. [Electronic resource]. — 27.07.2021. https://www.gazeta.ru/tech/2021/07/27/13787258/Robo_teacher.shtml

ized autonomous organizations, connecting the needs of customers and providers of products and services [6].

In some foreign universities, technology such as blockchain has begun to be used in the preparation of graduation theses by students. The use of technology allowed teachers to track the dynamics of progress in completing the thesis more effectively. Russian universities are also introducing innovations into the educational process, mastering new educational programs. Students of the MIPT master's program "Blockchain" in 2022 received diplomas in the form of non-fungible tokens (NFT).

Smart contract technology makes it possible to create digital smart didactics using cloud and blockchain technologies in order to develop the education system as a whole and promote the greater effectiveness of personal development of students. Digital smart didactics makes it possible to increase the efficiency of graduate training, create a personalized educational trajectory, and connect the student's development with an increase in entrepreneurial culture and personnel training in the process of creating a startup. This approach could also be based on principles of building decentralized autonomous organizations, making it possible to tie together the needs of customers and the needs of suppliers of products and services [6].

Such technologies will help educational institutions to pay more attention to each student, to reduce the unpleasant for traditional higher education system factors, when more than 20% of students fail to cope with education and drop out, or are demotivated by its low quality, as well as the percentage of students who later work outside their field of study, which indicates the inefficiency of spending public funds and non-compliance of the education system with modern requirements.

By using of blockchain technology, industry representatives and partners of universities could adjust faster to educational programs and supplement them with the necessary skills and competencies that students need to acquire.

Dell Technologies specialists found out, that the following digital technologies will have a significant impact on society in the world by 2030: machine learning and artificial intelligence, robotics, virtual and augmented reality, cloud computing [2].

If the Russian government wants to create a digital economy, it is necessary to make changes in the education system by introducing the above mechanisms that facilitate the interaction between business structures and universities, involving business community in order to modernize educational programs and organizing as well as internships for teachers.

The program of the Digital Economy of the Russian Federation started in 2017 is supposed to improve the education system in order to provide the digital economy with competent personel[18].

One of the ways of digitalization of education is the development and implementation of online educational courses, it will increase the role of educational technologies in teachers' work. On the one hand, the expansion of the range of educational technologies helps students to obtain "a guaranteed specified educational result" [13]. On the other hand, the level of teachers' mastery of digital technologies is rather low.

Methodology This study analyzes the application of digital technologies in education, highlights the most promising ones from the point of view of teachers' application in the educational process.

[18] On the strategy for the development of the information society in the Russian Federation for 2017–2030. Decree of the President of the Russian Federation dated May 9, 2017 No. 203 Official Internet portal of legal information. [Electronic resource]. URL://www.pravo.gov.ru/news/2017/news_0105.html (access date 01.10.2022).

To determine the readiness of teachers to use digital educational technologies, we analyzed domestic and foreign scientific publications on how digital technologies were used by teachers of educational institutions.

There are many studies that highlight the importance of using digital technologies to improve student learning. Various factors influence receptiveness of teachers to technology. Gender and age of teachers are important factors, which influence ICT training of the teaching staff [14]. The results of individual studies indicate that female teachers had greater digital competence in the use of ICT than male teachers [15—19]. In terms of age, young teachers have more knowledge; moreover, recent graduates feel more confident when introducing these technologies [20; 21]. An important factor is the level of readiness of the leaders to inform about changes when introducing digital technologies into teaching and learning in the higher education system [19].

In Russian publications there is a small number of works related to the readiness and ability to use digital educational technologies by teachers [22—25] with different assessments. The study [24] identifies among teachers "skeptics" and "enthusiasts" according to their use of digital educational technologies, the group of "enthusiasts" makes up 48.7% (73 people). The paper [25] revealed that the readiness of future teachers to use innovative technologies is influenced by various factors, such as the degree of motivation to use innovative technologies, "creativity, communication and organizational abilities." Another article revealed the low level of qualifications of teaching staff regarding the use of information and communication technologies. More than 50% of teachers do not have a "clear idea of what needs should be to implement the project." The main barriers are identified:

1) so-called "risky" barriers, due to the fact that teachers believe that digital technologies have a negative impact "both on society and on the individuals and their education", about 50% (47.13%) of teachers who participated in a survey, work in The Sverdlovsk region. They see more shortcomings than prospects in the use of social networks and messengers in teaching activities;

2) barriers associated with the ruining the teacher's image, which comes as a result of the availability of the teacher's personal information in the social networks [24, p. 132]. About 1/3 of teachers insisted on the an inadmissibility (reluctance) to be registered on social networks;

3) barriers to the uptake and use of new digital technologies.

The study[19] shows that according to 32% of the 634 teachers of higher education do not confidently use digital technologies or do not use them at all. At the same time, the vast majority of teachers (more than 90%) actively use the Internet and do not experience difficulties in working on a computer and other digital devices. Moreover, 59% of them actively use social networks. This is evidenced by the high level of the digital literacy index of university teachers (88% out of 100 possible[20]).

Regarding the readiness of students to use digital competencies, it should be

[19] Aimaletdinov T.A., Baymuratova L.R., Zaitseva O.A., Imaeva G.R., Spiridonova L.V. Digital literacy of Russian teachers. / Readiness to use digital technologies in the educational process. — M.: NAFI Publishing House, 2019. — 84 p. URL: https://d-russia.ru/wp-content/uploads/2019/10/digit-ped.pdf

[20] Aimaletdinov T.A., Baymuratova L.R., Zaitseva O.A., Imaeva G.R., Spiridonova L.V. Digital literacy of Russian teachers. / Readiness to use digital technologies in the educational process. — M.: NAFI Publishing House, 2019. — 84 p. URL: https://d-russia.ru/wp-content/uploads/2019/10/digit-ped.pdf

noted that despite the relatively low level of development of basic digital skills of Russians[21, 22], Russian students have a higher level of digital literacy, which makes 77% out of 100 possible. This level is lower than that of teachers, but much higher than the average for the Russian population (52% out of 100%). At the same time, with the development of critical thinking the self-assessment of the level of digital literacy of students becomes lower, and the demand for the use of digital technologies in the educational process increases. Among 248 undergraduate students of 1st — 4th year of the university in non-digital areas at Novosibirsk State University of Economics and Management ("Human Resources Management", "Management", "Economics") [26], only 25% of respondents assessed the disciplines in the curricula as useful to increase their own digital literacy level are sufficient, 34.5% of respondents claimed that these disciplines at the university are extremely insufficient. In addition, the research [27] showed that PhD students have significantly higher readiness to use digital technologies than bachelor students s and those to study to be a Doctor in Sci.

It can be noted that there is an imbalance between the level of digital literacy and readiness to use digital technologies in teaching. However, university teachers, having a fairly high level of digital literacy, are not striving to introduce new technologies into practice. While students, who also have a high level of digital literacy, want to increase it through the introduction of new technologies in the educational process (expecting this from the teacher as well).

On the one hand, the level of development of basic digital skills of the Russian population is far behind in comparison with similar indicators in European countries. The State strives to accelerate digitalization in all sectors of the economy through the implementation of programs such as "Digital Economy of the Russian Federation" and "Priority 2030"; on the other hand, employers need trained personnel with a high level of digital proficiency, creating a demand for competent specialists. At the same time, the readiness and ability to use digital technologies in the educational activities at universities is different for different participants, the question is whether the main participants of the educational process, both teachers and students — are ready to use them.

To analyze the readiness of students to use digital technologies in education, we carried out an analysis of scientific publications and conducted a sociological study using online survey in Google among students in the areas of ICT at ITMO University. The survey described the frequency of use of digital technologies by students, the degree of their awareness of specific digital tools, and the level of use of such tools by teachers in the educational process. 100 undergraduate and master students took part in this. The survey was conducted on a voluntary and anonymous basis. Respondents were found in social networks, messengers and the portal of ITMO University. The survey was conducted from December 2021 to July 2022.

In the study, the authors used systematic analysis and comparative analysis, methods of generalization, and systematization of the analytical grouping.

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[22] Abdrakhmanova G.I., Vishnevsky K.O., Gokhberg L.M. and others. Digital economy: 2020. / Brief statistical collection. — M.: National Research University Higher School of Economics, 2020. — 112 p.

Results

To analyze the readiness to use digital educational technologies for students who have an understanding of various digital technologies, ITMO University students of ICT were invited to participate in the study. The results (Fig. 1, Fig. 2) showed that a significant proportion of students (70%) used four technologies: computer equipment (84 people), mobile Internet (82 people), multimedia (projector, speakers, TV) (81 people), software systems (programming languages, translators, compilers, operating systems, software packages, etc.) (71 people).

49 to 51 out of 100 respondents used during their education the high-speed Internet (49 people), local information networks (51 people), 3D modeling and prototyping (49 people), information system for students and employees (47 people). The last figure is interesting,, since currently all students interact with a system of this type, however, only 47 out of 100 noted this, which may be either due to a misunderstanding of what is meant by “information system for employees and students”, or a different interpretation of it by the students..

Analyzing the use of digital services, the following services were identified: Kahoot (74 people), Online Test Pad (65 people), Quizizz — (45 people). The functionality of the seservices is quite similar, so are simplicity, easy to use and variability of the functions.

The answers to question about full understanding of the essence and use of im-

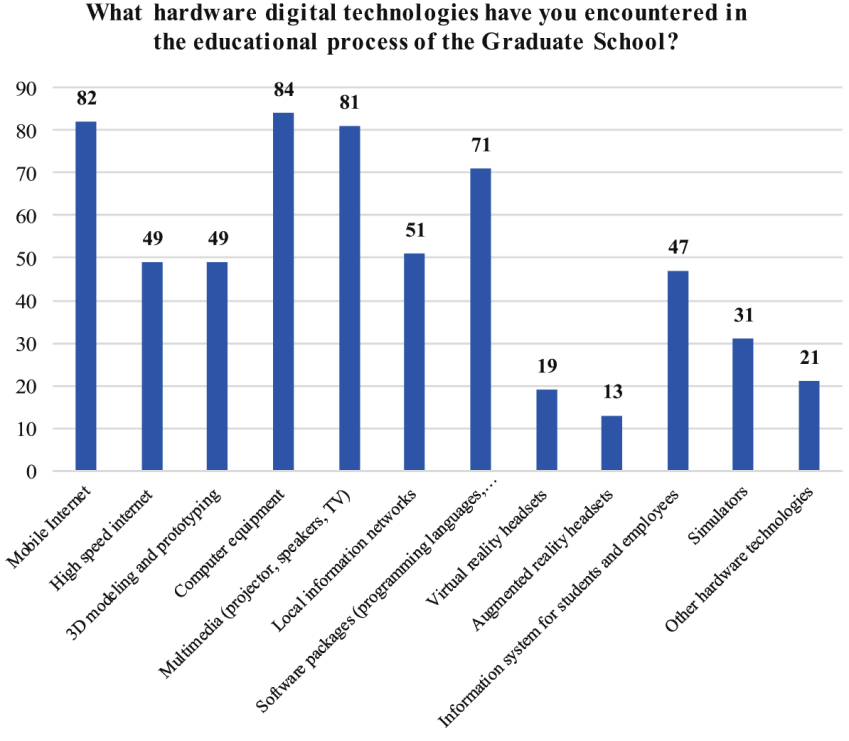

Fig. 1. The level of use of hardware digital technologies in the educational process

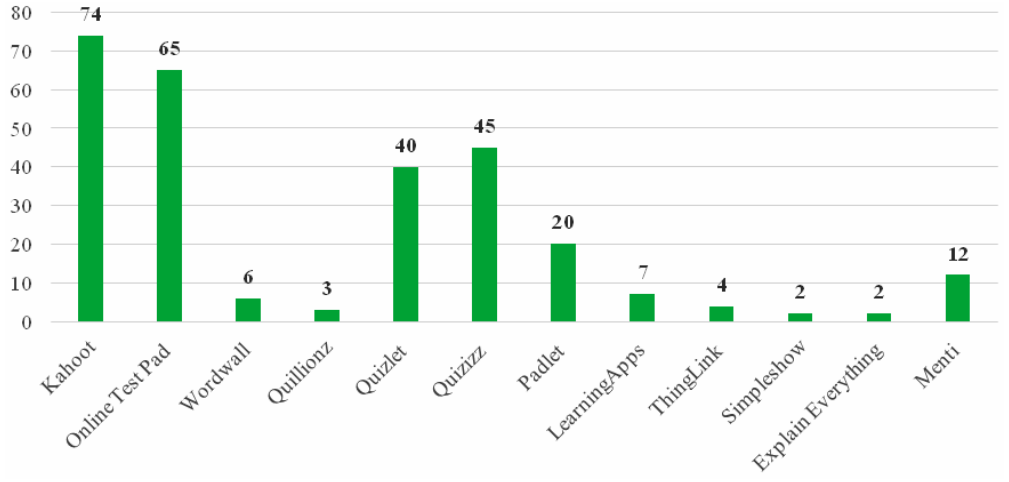

Fig. 2. Level of use of digital interactive services in education

mersive technologies showed that the majority of respondents were not familiar with this concept (62%). Further questions were about students' experience in using virtual reality (VR), augmented reality (AR), and 360-degree video technologies. 56% of respondents indicated that they used a virtual reality headset and only 38% claimed having used an augmented reality headset. This indicates that students are not fully aware of the essence of the concept of immersive technologies and they don´t identify them with virtual or augmented reality technologies. As for 360-degree video, which also makes it possible to immerse students in a certain environment, 61% of respondents mentioned this technology.

There are several factors which are important for the large-scale development of the technology, , relating not only to technical characteristics and cost, but also to the positive experience students (customers) had. 43% of the respondents who had experience using a VR headset, rated their experience as 8-10 out of 10. Only two respondents gave 5 points, which was the lowest rating among all respondents, indicating a high degree of perceived positive user experience and high user satisfaction (Figure 3).

However, despite the positive assessment in general, VR headsets, like other technologies, have disadvantages associated with both economic factors (high price) and technical ones. The number of respondents who encountered discomfort using a VR headset is almost equal to the number of those who did not experience discomfort (51% and 49%, respectively). This may indicate inherent shortcomings in the technology that are important to half of consumers and have a significant potential for technical improvement.

Discomfort among users when using a VR headset was associated with several factors: dizziness (9 people), headaches (4 people), eye fatigue (4 people), sweating of the face and tearing (4 people), difficulties in orientation in space (5 people), technical shortcomings (excessively heavy weight of the headset, bad fit to the face, uncomfortable ergonomics, flickering, bad quality of the graphics, long connection time) (5 people).

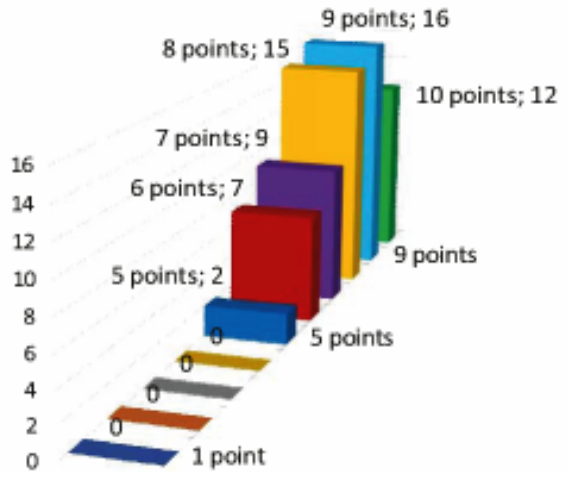

Fig. 3. Rating the experience of using a VR headset from 0 to 10 scores (scores/person)

In addition to AR headsets, users usedother types of devices (Figure 4).

At the same time, the majority of respondents believe that the use of virtual reality technologies can improve the quality of education, and only 8 people thought that they could not (Fig. 5).

Regarding the duration of using VR and AR headsets, the majority believe that VR headset can be used no more than 4 hours a day (40 people), respondents are more cautious about AR headsets and the majority (25 people) do not recommend using it more than 2 hours a day (Table 1).

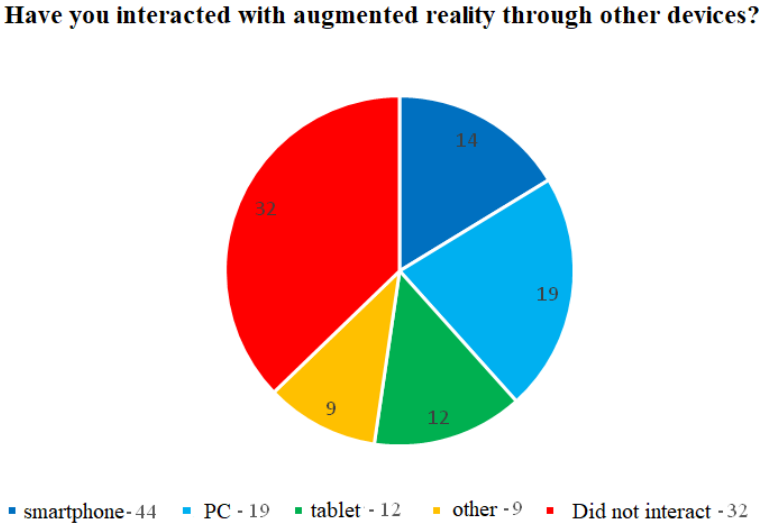

Fig. 4. Devices used to interact with augmented reality (persons)

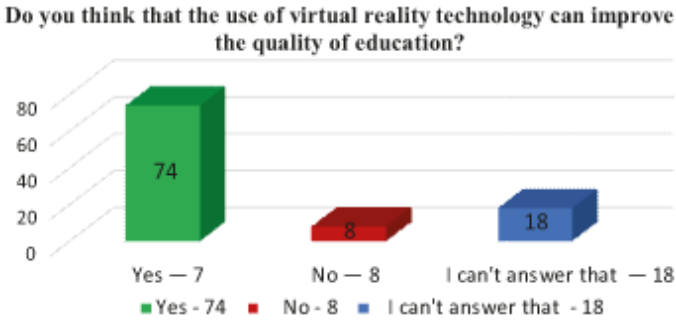

Fig. 5. Can the use of virtual reality to improve the quality of education (persons)

Table

Results of a surveys of students on the duration of use of VR and AR headsets per day

Use of VR glasses per day		Use of AR glasses per day	
Duration, hours	**Number of respondents who chose the option, persons**	**Duration, hours**	**Number of respondents who chose the option, persons**
No more than 4	40	No more than 4	-
up to 2	16	up to 2	25
up to 3	-	up to 3	11
up to 1	11	up to 1	10
0,5	5	0,5	2
5	5	4-8	1
6	1	6-8	1
-	-	14	1
2	1	24	2

The most popular VR headset manufacturers were: Oculus, HTC and Sony (Fig. 6).

Regarding the use of VR headsets, according to respondents, it is most useful and interesting to use it in the study of various disciplines: chemistry (1st place), 3D modeling (2nd place), physics (3rd place), as well as history, astronomy, biophysics, circuit design, electrical engineering, systems administration, economics, geography, mathematics, geometry, biology, driving courses and psychology.

A very small number of respondents (7%) have their own VR headset, while 35% would like to purchase a VR headset (Fig. 7).

Respondents' opinion on the frequency of using a VR headset range from several times a day to several times a year (Fig. 8)

The main reasons explaining why a significant portion of respondents do not use a headset are lack of financial means, high cost (8 people), no time to use (2 people), safety (2 people) and other reasons (Fig. 9) .

External reasons for the wide use of remote learning services were dictated by the pandemic. Different educational organiza-

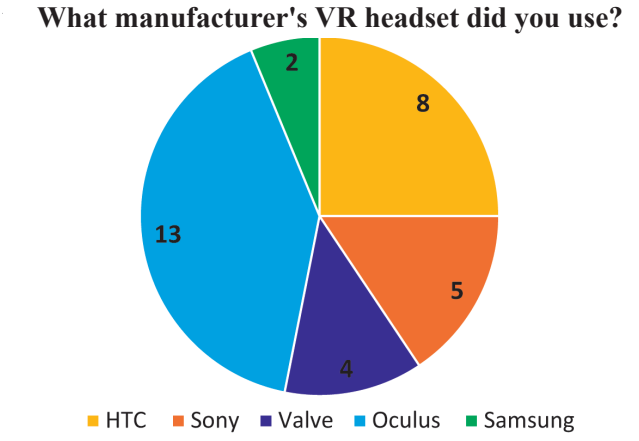

Fig. 6. The most popular VR headset manufacturers

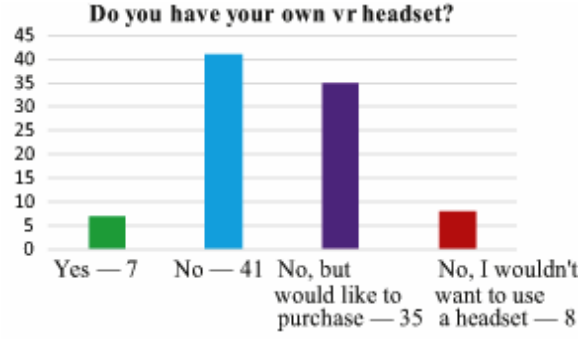

Fig. 7. Students having their own VR headset

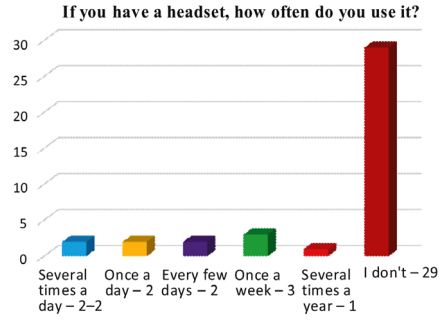

Fig. 8. Frequency of use of the headset by users (persons/times)

tions and teachers have chosen their preferred services by their own experience. A number of teachers chose digital services for distance classes based on their audience preferences. As a result, the majority of respondents used different services dur-

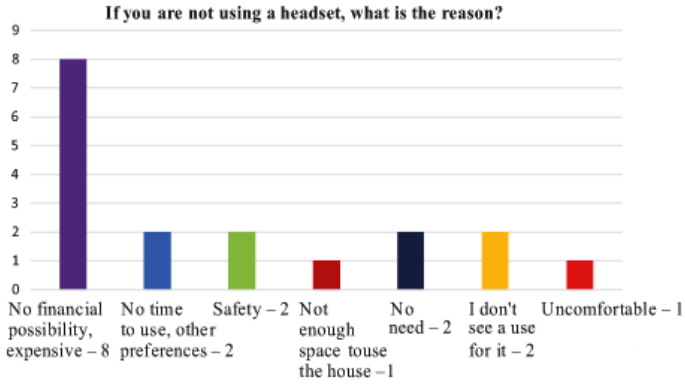

Fig. 9. Reasons for not using a headset

ing the learning process. The most popular remote learning services turned out to be: Zoom, Discord, Google class, Skype, VK (Fig. 10).

A new stage in the development of both VR/AR technologies and educational technologies will be their use in *metaverses*. Some innovative teachers have already tried to implement their courses via computer games and the Roblox metaverse.

As the survey results showed, only a small number of respondents managed to try out a VR headset in the metaverses(9 participants), while 30 participants responded that they didn't have such experience (Fig. 11).

In some Asian countries, individual universities use educational technologies in metaverses. For instance, the University of Tokyo (Todai) is starting to implement a number of *educational programs in the metaverse*. The project is implemented by the Faculty of Engineering and the Graduate School related to Engineering. The course in the metaverse is planned to be open to everyone, both high school students and adults. By using the metaverse, developers want to make an access open for everyone to a high-quality education in

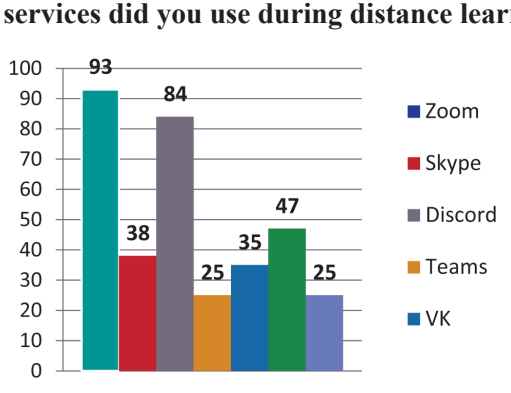

Fig. 10. Most popular remote learning services (%)

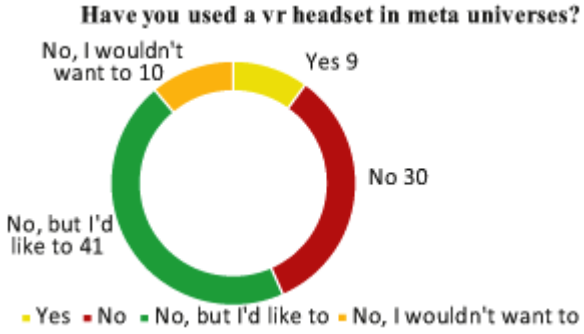

Fig. 11. Have you used a VR headset in the metaverses?

the field of engineering and computer science[23].

The University of Hong Kong (Hong Kong University of Science and Technology) started teaching in virtual classrooms and planned to launch a campus in the metaverse[24].

China has announced a two-year plan for the development of *metaverses* in 2022—2024. The plan is intended to stimulate the development of the Web 3.0 Internet and focuses on promoting the development of sectors related to metaverses, as well as smart city management for the digital economy[25]. This way China is trying to promote development scenarios of the digital education, strengthen cooperation between technology companies and educational institutions, expand interactive online education models and develop new digital teaching platforms. The action plan for the development of the metaverse became an impetus for providing all possible support for the development of virtual reality in districts and municipalities.

Russia also has started implementing educational projects related to metaverses. At the annual conference "Digital Industry of Industrial Russia" held in Nizhny Novgorod, was presented a prototype of the country's first educational metaverse, Neymark.MetaVerse. It was created by the Gorky Center for Artificial Intelligence in cooperation with the Project Office for the Development Strategy of the Nizhny Novgorod region and the IT company AVM Technologies[26]. The EdTech company Geek Brain launched a twelve-month course: "Developing Metaverses. Advanced Technologies of the IT Engineering: Metaverses".

Conclusion

The perspectives for introducing new digital technologies into the educational

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[26] The prototype of Russia's first educational metaverse "NEIMARK.MetaVerse" was presented at Digital industry of industrial Russia. Nizhny 800. — 02.06.2022. [Electronic resource]. https://nizhny800.ru/news/prototip-pervoj-v-rossii-obrazovatelnoj-metavselennoj-nejmark.metaverse-predstavili-na-cipr?ysclid=l91q8abry l965964142 (access date: 10.01.2023).

process open up a number of positive opportunities for improving the educational system. There is a significant part of business processes that can be automated using RPA technologies and AI algorithms.

The use of virtual educational environments can significantly improve the quality of education and implement the best educational practices. Gaming ecosystems like Roblox facilitate the gamification of the learning process and help to experience the benefits of a virtual environment, but they have limited functionality compared to the metaverse. Environments such as Minecraft, Roblox or Fortnite are too connected to the gaming style and can be unnecessarily distracting. However, it did not stop some innovative teachers from conducting their educational courses in these environments. The use of digital technologies has a lot of positive aspects, but also a number of significant risks. In the case of using virtual educational environments, there are limitations for using headsets students with sensory dysfunction

According to the surveys, headsets have a number of disadvantages; their if used for a long time it can cause dizziness, headaches, eye fatigue and a number of other negative consequences. If headsets are used for educational and also for entertainment, then their usecan be excessive. The main obstacle limiting the spread of virtual reality headsets is their price.

To improve teachers' ability to use these new technologies, it is necessary to introduce courses on the use of digital educational technologies professional curricula. Educational centers for teachers should support it in the following ways: (a) to create courses and seminars on the use of digital educational technologies; (b) to organize open events, panel discussions about best practices, where professionals could get new information regarding new methods of adding digital educational technologies. We also propose to encourage teachers to use technology in the educational process by providing them with additional funding, for example, project grants. Universities need to create conditions for students in order have access to the digital technologies.

This research may be useful for developing approaches to teaching IT professionals. In future researchers should try to identify ways to improve the effectiveness of teachers' use of sdigital educational technologies.

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