BRAIN. Broad Research in Artificial Intelligence and Neuroscience
ISSN: 2068-0473 | e-ISSN: 2067-3957
Covered in: Web of Science (WOS); PubMed.gov; IndexCopernicus; The Linguist List; Google Academic; Ulrichs; getCITED; Genamics JournalSeek; J-Gate; SHERPA/RoMEO; Dayang Journal System; Public Knowledge Project; BIUM; NewJour; ArticleReach Direct; Link+; CSB; CiteSeerX; Socolar; KVK; WorldCat; CrossRef; Ideas RePeC; Econpapers; Socionet.

2022, Volume 13, Issue 2, pages: 22-38 | https://doi.org/10.18662/brain/13.2/329
Submitted: February 2nd, 2022 | *Accepted for publication:* June 1st, 2022

Distance Learning of Foreign Languages through Virtual Reality

Lesia KONDRATIUK[1],
Svitlana MUSIICHUK[2],
Nelia ZUIENKO[3],
Yuriy SOBKOV[4],
Olha TREBYK[5],
Dmytro YEFIMOV[6]

[1] Ivan Chernyakhovsky National Defense University of Ukraine, Lnkon@ukr.net
[2] National University of Food Technologies, Ukraine, svetlana.museichuk@gmail.com
[3] National University of Life and Environmental Sciences of Ukraine, znelja@gmail.com
[4] Chernivtsi National University, Ukraine, y.sobkov@chnu.edu.ua
[5] Interregional Academy of Personnel Management, Ukraine, Folktaleolga@gmail.com, https://orcid.org/0000-0003-4467-9193
[6] Horlivka Institute for Foreign Languages of State Higher Educational Institution "Donbas State Pedagogical University", Ukraine, jaster19911@gmail.com, https://orcid.org/0000-0001-6317-5287

Abstract: *The article is devoted to virtual reality technologies and scenarios of their application in distance learning of foreign languages. A generalized experience of application of virtual reality technologies in distance learning of foreign languages is presented; the advantages, risks and deterrents of their introduction into the educational process in educational institutions are highlighted. The features by which technologies can be classified as virtual reality technologies are singled out. Examples of application of the following virtual reality technologies are considered: Mondly VR, VirtualSpeech, Immersive VR Education, AltspaceVR and ClassVR; their brief description, scenarios for use in learning foreign languages, benefits and risks of use are provided. Summarizing the review of these technologies, it was found that the educational content of distance learning of foreign languages through virtual reality can be divided into three groups: "360-degree video", platforms and sites, interactive programs. Conditions and didactic principles of the effective use of virtual reality technologies during distance learning of foreign languages are generalized. The issue of assessing effectiveness of virtual reality technologies in learning foreign languages is analyzed and identified as debatable and in need of further research. The criteria by which researchers summarize the principles of selection of evaluation criteria are clarified. Perspective directions of future scientific investigations are outlined: research of conditions of intensification and research of scenarios of use of collective intelligence during distance learning of foreign languages through virtual reality.*

Keywords: *Distance learning, virtual reality technologies, immersive technologies, language environment.*

How to cite: Kondratiuk, L., Musiichuk, S., Zuienko, N., Sobkov, Y., Trebyk, O., & Yefimov, D. (2022). Distance Learning of Foreign Languages through Virtual Reality. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 13*(2), 22-38. https://doi.org/10.18662/brain/13.2/329

Introduction

The contemporary world cannot be imagined without the use of various gadgets and the use of technologies that are actively emerging (Sandu & Vlad, 2018) and being implemented in the field of education. The role of the teacher today has long been changed from the role of the bearer of knowledge. The teacher tries not only to transfer knowledge, but also to capture attention of the student to his / her discipline (Karasievych et al., 2021; Berbets et al., 2021; Sarancha et al., 2021; Demchenko et al., 2021; Prots et al., 2021; Kosholap et al., 2021; Onishchuk et al., 2020). In order for a foreign language teaching to be more effective, it is necessary to use the method of full immersion in the language environment. But it is not always possible to completely immerse oneself in the language environment. Therefore, educators try to use the latest technologies to find alternative approaches and teaching methods to create a language environment that is as close as possible to the real thing. The use of virtual reality technologies can significantly improve the quality of distance learning of foreign languages.

Virtual reality technologies are classified as immersive learning, which creates the "presence effect" using virtual and augmented reality gadgets. The range of applications of virtual reality technologies is quite wide, as these technologies can be used both for teaching young children and adult students, company employees and the elderly.

The purpose of the article is to analyze the application of virtual reality technologies in distance learning of foreign languages and to identify the pedagogical conditions for effectiveness of such educational activities.

Use of contemporary information and communication technologies (ICT) in the process of learning foreign languages

Researchers' interest in the use of contemporary information and communication technologies (ICT) in the process of learning foreign languages has been steadily increasing since the end of the 20th century. Trends in globalization and the use of foreign languages in international communication have led to the need for professionals in the labor market who can speak at least one foreign language and possess the conceptual and categorical apparatus and terminology in accordance with professional activities (Viktorova, Kocharian, & Mamchur, 2021). The urgency of the need for accelerated and high-quality foreign language learning is also partly due to the fact that in 2018 the European Parliament and the Council of the

European Union approved the Framework Program for the renewal of key competences, which are defined as competences for lifelong learning, which include multilingual competence (The Council of the European Union, 2018). And it is current ICT that allow to quickly and efficiently master foreign languages (Tadeieva, Kupchyk, & Litvinchuk, 2021).

Obviously, the emergence of the contemporary technologies that can be used to improve quality of education requires constant practical research (Lawrence & Tar, 2018). Scientific publications on this topic can be divided into two different groups. The first group is a traditional review of the methodological potential of a particular ICT tool (Mugaya, 2020), which focuses on practical application and relates mainly to the development of certain types of speech activities. The second group - studies aimed at analyzing the essence of the process of distance learning, identifying its specifics and prospects for maximum effectiveness (Alipichev, et al., 2016). The research of the second group concerns mainly full-fledged online courses of foreign languages, introduction of all forms of education into the educational process.

Among the positive qualities of distance learning using contemporary ICT, scientists note a higher level of psychological comfort as a result of individualization of the educational process (Sugie, 2014). At the same time, Morze (2015) and Kocharian (2016) state the insufficient level of information and communication competence of the academic staff, on which the quality of distance learning depends. The main disadvantage of distance learning, according to the scientists, is the lack of direct contact between the student and the teacher, which, according to their research, is an obstacle to the successful implementation of the competency approach (Shamina, 2019).

The beginning of the COVID-19 pandemic has only exacerbated the problem of distance learning in the context of the rapid search for various scenarios for addressing the quality of education through the use of contemporary ICT technologies, including virtual reality technologies.

The process of applying virtual reality technologies in the educational process is not new. Creation and implementation of virtual curricula in the educational process of educational institutions are addressed in the research of Kotsiuba (2013), which outline the basic definitions for learning a foreign language through virtual reality, specifically: the need for constant filling of modules, the universality of presentation and the effect of predicted expectations.

The study of virtual environments, as well as their use as a tool to influence learners are highlighted in the work of foreign authors Mikropoulos & Natsis (2011), who analyzed studies over ten years and found that although virtual reality supports multisensory channels interaction, however, the use of visual channels is dominated.

The use of immersive technologies in education has been reviewed by authors such as Cummings & Bailenson (2016), Potkonjak et al. (2016), whose research showed that the degree of technological immersion of the user in the virtual world does not significantly affect the quality of digesting information from the virtual world; in addition, researchers have proven that the visual channels of user immersion have an advantage in perception.

Theoretical analysis of distance learning of a foreign language through virtual reality

Digitalization is a global trend in higher education and if by 2020 it was limited to the use of sporadic ICT in education and traditional methods of learning foreign languages, in particular, since the COVID-19 pandemic a significant number of educational institutions are forced to switch to distance learning (Shevtsova & Kozubai, 2020). This forced rapid transition and unpreparedness of both scientific and pedagogical staff and material and technical resources only exacerbated the problem of using contemporary ICT in education.

Thus, analyzing the scientific literature, we can identify the following prerequisites for the interest of scientists in the use of virtual reality technologies in the learning of foreign languages:

- global informatization of society, which necessitates the development of information and communication competence (IC-competence) both in students and, accordingly, in the academic staff;
- expanding the profile of future activities of students, where knowledge of foreign languages is a significant advantage in the labor market;
- the constant need to solve problems of the education system as a whole: a contradiction between the rapid increase in scientific and professional information with the unwillingness to qualitatively structure it; contradictions between studies of new effective methods of teaching and training of specialists in the conditions of rapid development of ICT, etc.;

- contradictions between the needs of society in a variety of forms, methods and techniques for quality education in a short period of time and the inability of educational institutions to meet this demand;

- contradictions between the rapid development of contemporary ICT and virtual reality technologies, including the lack of detailed, consistent methods in distance learning of foreign languages through virtual reality.

Recent researches have shown that the most effective way to learn foreign languages is to completely immerse in the language environment. Constant exposure to a foreign language environment is the most effective method to learn a foreign language. The academic staff are constantly looking for such teaching methods that would be as close as possible to real life conditions. The problem of maintaining motivation and interest in learning can be solved by virtual reality (VR) technologies, which are used in gamification and allow to immerse in a foreign language environment and learn the language at a completely different level.

By virtual reality technology, we mean "advanced computer simulation that allows the user to delve into the artificial world and act directly in it with special sensory devices that connect them to audiovisual effects" (Klymniuk, 2018). Virtual reality technologies allow to interact with the learner through the senses: eyesight, hearing, sensation. Communicating with virtual characters in a foreign language in the virtual world is a great practice of pronunciation, building a dialogue, understanding another language. By involving more senses, the learning process becomes more efficient.

Analyzing scientific literature and scenarios for application of virtual reality technologies in the educational process, we consider it necessary to clearly distinguish between virtual reality technologies (Virtual Reality, VR) and augmented reality technologies (Augmented Reality, AR). These are two significantly different technologies. Augmented reality technology combines virtual objects with the real ones, overlays images of virtual objects and real objects. In the most cases this happens when a camera of the smartphone is pointed at a real object, and the screen of the smartphone displays the image of the real object with the image of the virtual object superimposed on it. Virtual reality involves immersing a person in an artificial simulated world with the involvement of eyesight, hearing, sensation and, sometimes, taste and smell. Thus, the main feature of VR is creation of the illusion of presence of the learner in a simulated computer environment.

The main features by which ICT (namely 3D visualization) can be attributed to the definition of virtual reality are as follows – the images must be stereoscopic and consistent with the coordinates of visual sensors; the system is equipped with a bidirectional interface (input - coordinates of visual sensors, output - images); the image refresh time in response to changes in sensor coordinates should not exceed 1/16 second (Foreman, 2014).

It should also be noted that the use of virtual reality technologies in education has led to the emergence of a virtual educational environment. By virtual educational environment we mean the information content and communication capabilities of local, corporate and global computer networks, which are formed and used for educational purposes by all participants in the educational process. The first virtual environment can be considered MUD (Multi User Dimension) - a full-text environment that works in chat mode (http://www.athena.edu). It was further developed in MOOD (Object-Oriented Multi User Dimension) - an object-oriented version of MUD, which allows users to create new objects and manipulate them to complete the worlds in virtual reality.

For further analysis of distance learning of a foreign language through virtual reality, we will consider examples of specific virtual reality technologies: Mondly VR, VirtualSpeech, Immersive VR Education, AltspaceVR and ClassVR.

Since 2017, the Mondly VR application (https://www.mondly.com) has become available to users. "Mondly: Learn Languages in VR" is a simulator game developed by ATi Studios A.P.P.S. SRL for PC platform. The environment in the game belongs to the style of modernity, and the features are the presence of a casual game, a simulator, training, VR, option for several players. A screenshot of the program image is shown in Figure 1. Using this application, the learner practices a foreign language and significantly increases one's vocabulary. A real situation is generated (visiting a museum, a restaurant, a theater; traveling by train or plane; communicating in a hotel or a taxi, and many others), which forces the learner to start and continue a dialogue. The application recognizes the language and the virtual character immediately responds to the words of the learner with the appropriate reaction: continuation of the dialogue, corrections, advice, requests to repeat, etc.

Fig. 1. *Screenshot from Mondly VR*
(https://mmo13.ru/games/mondly-learn-languages-in-vr)

It should be noted that to record the voice it is necessary to hover the mouse over the interface element with the image of the microphone and click on it (enable) - these additional actions are, in our opinion, unnecessary and make the interaction unrealistic and time-consuming. The learners do not have the opportunity to ask their own questions, the initiative and script always belong to artificial intelligence.

It is also worth focusing on the lexical component of the lessons. Mondly VR uses speech-to-text technology. Incorrect intonation leads to grammatical errors and incorrect use of vocabulary (for example, "I'll stay home until Sunday" instead of "I'm staying home until Sunday") – all this can make learning ineffective.

However, Mondly VR can be recommended as an additional tool for learning a foreign language or as a tool to correct errors. The application can be useful for A2 level learners to practice basic dialogues and to break down "the speech barriers".

The next software product that can be used in distance learning of a foreign language through virtual reality is VirtualSpeech (https://virtualspeech.com), which can be used as an additional element in a comprehensive system of foreign language learning. The distance course English for Business on the VirtualSpeech platform includes two components: a standard online course with video lectures, reading materials, tests and cases, practical exercises for application of theoretical knowledge in virtual reality. A screenshot of one of the program's scenarios is shown in Figure 2.

Fig. 2. *Screenshot from VirtualSpeech (https://virtualspeech.com/courses/interview-vr)*

VirtualSpeech offers over 50 lessons and 15 cases on VR. A typical scenario is watching a video lecture and reading texts. Then a student puts on a helmet of virtual reality, where a virtual situation of the real world unfolds (a visit to a restaurant, an interview, a meeting, etc.). The learner turns into a character who has to interact with other characters in the virtual world. All scenarios of the virtual world are based on real life situations and require an active participation of the learner. Examples of situations (courses) are: public speaking, the ability to say "no", talking to an angry client, holding a meeting, interview with a difficult leader, selling goods and services, etc.

In VirtualSpeech, the learner can upload one's own presentation and make a speech in front of a virtual audience, which according to the scenario will try to distract from the speech (moving characters around the virtual hall, turning off the microphone, accidentally spilled coffee, etc.). All this only brings the learner as close as possible to the real situation and requires the maximum "inclusion" in the practice of speaking and thinking in another language. It is also useful to be able to record one's own audio file.

Similar in functionality to VirtualSpeech is the following software product - Immersive VR Education (https://immersivevreducation.com), which can also be successfully used in the educational process of distance learning through virtual reality.

The next virtual reality technology is AltspaceVR (https://altvr.com), which allows to practice English with real people in the

virtual world. Each participant creates their own avatar and communicates with other real users in the virtual world. One can join a variety of virtual events: parties, interviews, presentations, games, etc. The main advantage of use is the ease of communication in the form of an avatar, which hides the real user.

ClassVR (https://www.classvr.com) is an educational VR platform with hundreds of ready-made various lessons dedicated to English language and culture. The platform is designed for teachers, but it has a separate independent curriculum with ready-made lessons for students. ClassVR offers augmented reality programs in which students can use textbooks and workbooks, which is an added bonus while learning. It is also worth noting that navigating around with a VR headset can be difficult. ClassVR has developed separate instructions and uses hand and head gestures to help students navigate in the virtual world and choose activities that are intuitive. The front camera can capture specific hand gestures, such as the thumb up, and uses it to select and launch the resource the learner is looking at. The head movements also control the device by rotating the resource icons so that the learner could find them to launch, or rotate around the image 360 degrees. An example of ClassVR instructions for use is shown in Figure 3.

The program includes English lessons on a variety of topics closely related to everyday life: shopping, school, weddings, etc.

Summarizing a brief overview of some VR technologies, we can state that the educational content of distance learning a foreign language through the virtual reality can be divided into three groups: "360-degree video", platforms and sites, interactive programs.

Fig. 3. *Screenshot from the ClassVR User's Guide (https://www.classvr.com/classroom-virtual-reality-lessons/student-independent-learning-gesture-control)*

"360-degree video", also known as the presence effect videos or spherical videos; video recording in which images are recorded simultaneously in all directions taken with a set of cameras; it allows to see the space at once from all sides.

On platforms and sites, a virtual learning environment is created in real time, when all participants in the process are simultaneously immersed in VR. Virtual lectures and workshops can be set as an example.

Interactive programs are finished products that are ready for use at lessons. For example, Minecraft Education or an online business English course – Virtual Speech. These are hybrid products of a traditional online course and practice in virtual reality.

There are plenty of VR technologies and educational VR content available on the market for learning foreign languages which can be easily found in the App Store, Google Play, or simply through the Google search engine. Usage examples and detailed descriptions can also be found on YouTube.

Conditions for effective use of virtual reality technologies during distance learning of foreign languages

After analyzing the scientific literature and reviewing modern virtual technologies that can be effectively used in distance learning, we agree with the researchers and believe that technologies for foreign language distance learning through virtual reality are best for wide practical application for the following reasons:

- the user does not need to have programming skills;
- the lack of an intermediate link between the teacher and the student allows to avoid negative psychological moments that prevent a wider introduction of virtual reality technologies in the educational process;
- the technology of virtual reality itself is rather universal - the same software product enables students of different specialties at different faculties to learn a foreign language;
- centralized automated learning management, fast and controlled access to educational content, a single unified platform, support for current standards and personalization of educational content and reusability - all these are examples of the many advantages of virtual reality technologies in learning foreign languages.

When using virtual reality technologies, administration of educational institutions, academic and teaching staff should be ready to address the following issues:

- distance learning courses for one language will require significant additional financial costs for translation and adaptation for learning another language;
- insufficient bandwidth of communication channels can reduce accessibility of distance learning;
- lack of specialists on development and implementation of virtual reality technologies;
- high cost of software development;
- work with objections to the effectiveness of the application and the myths of negative impact.

When organizing distance learning of foreign languages through virtual reality, we consider it necessary to adhere to the following didactic principles.

1. The principle of conscious and active learning. Only with a conscious goal of their own learning and the focus on the end result (answer to the question "Why do I need to learn a foreign language?") one can achieve effectiveness of this form of learning. It should be understood that virtual reality technology is just a tool in the hands of a teacher. The very fact of using this tool will not ensure effectiveness of training. A sign of conscious mastery of educational material is the degree of independence of the student; the higher this degree, the more consciously this knowledge is mastered.

2. The principle of systematicity and consistency implies a logical sequence and connection between the training courses studied at different stages of learning, and each time the training material should be based (superimposed) on the training material studied earlier.

3. The principle of availability of virtual reality technologies for distance learning of foreign languages today remains open due to the expensive resources for their development. However, the rapid development of ICT allows for a rapid decline in the cost of such resources.

4. The principle of modular construction of the content of distance learning through virtual reality. Each area of study should be represented by a separate block. Each block should be represented by separate modules that cover individual topics. The content of modules and blocks, respectively, can be adjusted depending on specific conditions, such as the level of

knowledge of students or their psychological and physiological characteristics, etc. One of the results of the modular learning is formation of self-education skills in the student. The process of modular distance learning through virtual reality is based on conscious goal-setting with its own hierarchy of the short-term (knowledge, skills, abilities), medium (21st century skills) and long-term (development of personal abilities) goals. It is the awareness of students of their own educational activities that transfers the teacher from the mode of information (the role of the bearer of knowledge) in the mode of counseling and management. The method of modular learning in distance learning of foreign languages through virtual reality allows to provide a free choice of a way of training - so the individual trajectory of training is constructed.

5. The principle of transition to self-education. During the Fourth Industrial Revolution, the knowledge acquired in educational institutions by students is rapidly aging. That is why the trend of "lifelong learning" is gaining momentum in recent years. And a conscious approach to distance learning allows to form a habit of lifelong learning.

Debatable issue of assessing the effectiveness of virtual reality technologies in mastering foreign languages

The issue of assessing the effectiveness of the use of virtual reality technologies in distance learning of foreign languages remains open. To create an assessment system, researchers summarize the following principles of assessment criteria selection: objectivity (allows to assess the selected indicator unambiguously), adequacy (allows to assess those indicators that really affect the quality of distance learning using virtual reality technologies), sustainability (the indicator should be constant for a certain period of application of virtual reality technologies in the educational process).

In addition, the following requirements should be applied to measure the effectiveness of the use of virtual reality technologies in distance learning of foreign languages:

- the technology of virtual reality in distance learning of foreign languages should be described sufficiently completely;
- measurement methods, methods and means of mathematical processing of the obtained data should ensure measurement of parameters in static and dynamic states.

At the moment, we believe that the scientific literature sufficiently describes the general issues of assessing quality of learning using distance

learning technologies in general. There are also detailed descriptions, scenarios for the use of individual ICT tools during distance learning. In the scientific literature we come across generalized principles of construction of distance learning systems including didactic, pedagogical principles and prerequisites for their effective use. However, we do not find systematic research related to measuring effectiveness of distance learning of a foreign language through virtual reality. This area of research, in our opinion, is promising for further study.

Prospects for further scientific research

We also consider the study of the conditions for intensification of distance learning of foreign languages through virtual reality to be a promising area of further research. By intensification we mean the maximum use of internal reserves of the learning process through the rational allocation of time, compression of educational material, activation of cognitive activity of students and stimulating their motivation to learn. In our opinion, many problems of intensification of distance learning of foreign languages through virtual reality will only become more acute over time and, accordingly, will require solutions. The impetus for these problems, in our opinion, is the ever-increasing amount of educational information, the expansion of intersectoral knowledge, which are necessary for successful professional activity. That is why the search for an effective intensification of distance learning will resolve the contradictions between the amount of necessary training material and the terms of training for which they need to be effectively mastered.

We also consider the study of scenarios for the use of collective intelligence during distance learning of foreign languages through virtual reality to be one of the promising areas of further research. A few years ago, the very concept of collective intelligence was defined by sociologists as the ability of a group of people to find more productive solutions compared to a particular member of the group. In the context of global digitalization, collective intelligence is considered in the theory of artificial intelligence as a method of optimization and, in our opinion, can be a promising area for finding optimization and improving the quality of teaching.

Also, we believe that with the advent of distance learning courses for a foreign language through virtual reality, in our opinion, we need to detail the concept of "blended learning", where instead of the classroom component there is a component of virtual reality.

Conclusion

Due to the advent of VR technology, it has become possible to significantly improve modern methods of teaching foreign languages. In recent years, the practice of teaching foreign languages is increasing using VR technologies, which significantly improve motivation of students, their communication and collaboration through ICT.

Introduction of VR in the process of learning foreign languages has numerous advantages:

- three-dimensional models allow to capture the attention of students and involve them in the active cognitive and communicative activities;
- students completely immerse in real life situations created in the virtual world; they have to react quickly and focus on the content of dialogues;
- simultaneous visual and auditory perception of information provides high efficiency of speech communication;
- availability of different avatars provides an opportunity to conceal one's real character thus avoiding the fear of communicating with strangers;
- individualization and personalization of the educational process;
- as a result, immersion in the language environment increases vocabulary, improves hearing perception of the language, improves memory, attention and thinking.

Thus, virtual reality can be considered an effective method of teaching foreign languages. The development and implementation of this unique state-of-the-art technology requires systematic research on important issues such as methodology and technical equipment. Analysis of virtual reality technologies shows that it can be used as an effective tool in teaching foreign languages.

References

Alipichev, A. Y., Khalevina S. N., Trubcheninova, A. A., & Fedulova, A. N. (2016). Practical solutions to foreign language training courses implemented using distance learning tools. *International Electronic Journal of Mathematics Education*, *12*(1), 59-68. https://www.iejme.com/article/practical-solutions-to-foreign-language-training-courses-implemented-using-distance-learning-tools

Berbets, T., Berbets, V., Babii, I., Chyrva, O., Malykhin, A., Sushentseva, L., Medynskii, S., Riaboshapka, O., Matviichuk, T., Solovyov, V., Maksymchuk, I., & Maksymchuk, B. (2021). Developing Independent

Creativity in Pupils: Neuroscientific Discourse and Ukraine's Experience. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, *12*(4), 314-328. https://doi.org/10.18662/brain/12.4/252

Cummings, J. J., & Bailenson, J. N. (2016). How immersive is enough? A meta-analysis of the effect of immersive technology on user presence. *Media Psychology, 19* (2), 272–309. https://vhil.stanford.edu/mm/2015/cummings-mp-how-immersive.pdf

Demchenko, I., Maksymchuk, B., Bilan, V., Maksymchuk, I., & Kalynovska, I. (2021). Training Future Physical Education Teachers for Professional Activities under the Conditions of Inclusive Education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12*(3), 191-213. https://doi.org/10.18662/brain/12.3/227

Foreman, N. (2014). Proshloe i buduschee 3-D tehnologiy virtualnoy realnosti [Past and future of 3-D virtual reality technologies]. *Scientific and Technical Bulletin of the St. Petersburg State Institute of Fine Mechanics and Optics, 6*(94), 1-8. https://ntv.ifmo.ru/ru/article/11182/proshloe_i_buduschee_3-D_tehnologiy_virtualnoy_realnosti_.htm

Karasievych, S., Maksymchuk, B., Kuzmenko, V., Slyusarenko, N., Romanyshyna, O., Syvokhop, E., Kolomiitseva, O., Romanishyna, L., Marionda, I., Vykhrushch, V., Oliinyk, M., Kovalchuk, A., Halaidiuk, M., & Maksymchuk, I. (2021). Training Future Physical Education Teachers for Physical and Sports Activities: Neuropedagogical Approach. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, *12*(4), 543-564. https://doi.org/10.18662/brain/12.4/264

Klymniuk, V. Ye. (2018). Virtualna realnist v osvitnomu protsesi [Virtual reality in the educational process]. *Collection of scientific works of Kharkiv National University of the Air Force, 2,* 207-212. http://nbuv.gov.ua/UJRN/ZKhUPS_2018_2_30

Kocharian, A. B. (2016). *Rozvytok informatsiino-komunikatsiinoi kompetentnosti naukovo-pedahohichnykh pratsivnykiv humanitarnykh spetsialnostei klasychnykh universytetiv* [Development of information and communication competence of scientific and pedagogical workers of humanitarian specialties of classical universities]. [Doctoral dissertation, Institute of Information Technologies and Teaching Aids of the National Academy of Pedagogical Sciences of Ukraine]. Digital Library NAPS of Ukraine. https://core.ac.uk/download/pdf/77241187.pdf

Kosholap, A., Maksymchuk, B., Branitska, T., Martynets, L., Boichenko, A., Stoliarenko, O., Matsuk, L., Surovov, O., Stoliarenko, O., & Maksymchuk, I. (2021). Neuropsychological Bases of Self-Improvement of Own Physical Health of Future Teachers in the Course of University Education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12*(3), 171-190. https://doi.org/10.18662/brain/12.3/226

Kotsiuba, R. B. (2013). Vykorystannia virtualnykh navchalnykh prohram pry vyvchenni inozemnoi movy profesiinoho spriamuvannia [The use of virtual educational programs in the study of a foreign language for professional purposes]. *Informatsiini tekhnolohii i zasoby navchannia, 37*(5), 43-52. http://nbuv.gov.ua/UJRN/ITZN_2013_37_5_7

Lawrence, J. E., & Tar, U. A. (2018). Factors that influence teachers' adoption and integration of ICT in teaching/learning process. *Educational Media International*, *55*(1), 79-105. https://www.tandfonline.com/doi/abs/10.1080/09523987.2018.1439712

Mikropoulos, T. A., & Natsis, A. (2011). Educational virtual environments: A ten-year review of empirical research (1999-2009). *Computers and Education. 56*(3), 769–780. https://www.sciencedirect.com/science/article/abs/pii/S0360131510003052?via%3Dihub

Morze, N. V. (2015). Informatsiino-komunikatsiina kompetentnist naukovo-pedahohichnykh pratsivnykiv universytetu. Istorychnyi rozvytok formuvannia poniatiinoho aparatu [Information and communication competence of scientific and pedagogical staff of the university. Historical development of the formation of the conceptual apparatus]. *Pedahohichna osvita: teoriia i praktyka. Psykholohiia. Pedahohika,* 24. http://nbuv.gov.ua/UJRN/Potip_2015_24_5

Mugaya, T. S. (2020). Using ICT to Improve Teaching and Learning of Kiswahili Language for University Students. *International Journal for Educational and Vocational Studies*, *2*(4). https://ojs.unimal.ac.id/index.php/ijevs/article/view/2528

Onishchuk, I., Ikonnikova, M., Antonenko, T., Kharchenko, I., Shestakova, S., Kuzmenko, N., & Maksymchuk, B. (2020). Characteristics of Foreign Language Education in Foreign Countries and Ways of Applying Foreign Experience in Pedagogical Universities of Ukraine. *Revista Romaneasca Pentru Educatie Multidimensionala*, *12*(3), 44-65. https://doi.org/10.18662/rrem/12.3/308

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrovic, V. M., & Jovanović K. (2016). Virtual laboratories for education in science, technology, and engineering: A review. *Computers and Education, 95*, 309–327. https://doi.org/10.1016/j.compedu.2016.02.002

Prots, R., Yakovliv, V., Medynskyi, S., Kharchenko, R., Hryb, T., Klymenchenko, T., Ihnatenko, S., Buzhyna, I., & Maksymchuk, B. (2021). Psychophysical Training of Young People for Homeland Defence Using means of Physical Culture and Sports. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 12*(3), 149-171. https://doi.org/10.18662/brain/12.3/225

Sandu, A., & Vlad, L. (2018). Beyond technological singularity - The posthuman condition. *Postmodern Openings, 9*(1), 91-102. https://doi.org/10.18662/po/07

Sarancha, I., Maksymchuk, B., Gordiichuk, G., Berbets, T., Berbets, V., Chepurna, L., Golub, V., Chernichenko, L., Behas, L., Roienko, S., Bezliudna, N., Rassskazova, O., & Maksymchuk, I. (2021). Neuroscientific Principles in Labour Adaptation of People with Musculoskeletal Disorders. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, *12*(4), 206-223. https://doi.org/10.18662/brain/12.4/245

Shamina, N. V. (2019). Onlayn-obuchenie v obrazovatelnom protsesse: silnyie i slabyie storonyi [Online learning in the educational process: strengths and weaknesses]. *Kazanskiy pedagogicheskiy zhurnal, 2,* 20–24. https://cyberleninka.ru/article/n/onlayn-obuchenie-v-obrazovatelnom-protsesse-silnye-i-slabye-storony

Shevtsova, P., & Kozubai, I. (2020). Distance foreign language learning during the pandemic as a challenge for the education system. *Proceedings of the conferences of the Youth Scientific League,* 57-59. https://ojs.ukrlogos.in.ua/index.php/liga/article/view/2532

Sugie, S. (2014). Practice and evaluation of blended learning with cross-cultural distance learning in a foreign language class: Using mix methods data analysis. *Journal of Pan-Pacific Association of Applied Linguistics*, *18*(2), 1-19. https://eprints.lib.hokudai.ac.jp/dspace/handle/2115/63945

Tadeieva, M.I., Kupchyk, L.Ye., & Litvinchuk, A.T. (2021). Vykorystannia zasobiv IKT dlia formuvannia navchalnykh i komunikatyvnykh stratehii pid chas vyvchennia inozemnoi movy u nemovnykh zakladakh vyshchoi osvity [The use of ICT tools for the formation of educational and communicative strategies in the study of a foreign language in non-language institutions of higher education]. *Informatsiini tekhnolohii i zasoby navchannia, 81*(1), 272-284. http://nbuv.gov.ua/UJRN/ITZN_2021_81_1_20

The Council of the European Union (2018). Council Recommendation of 22 May 2018 on key competences of lifelong learning (Text with EEA relevance). *Official Journal of the European Union*. 189/1–189/13. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&rid=7

Viktorova, L.V., Kocharian, A.B., & Mamchur, K.V. (2021). Vykorystannia tekhnolohii potokovoi peredachi danykh u navchanni doroslykh na prykladi Nearpod [The use of streaming technology in adult education on the example of Nearpod]. *Informatsiini tekhnolohii i zasoby navchannia, 82*(2), 266-281. http://nbuv.gov.ua/UJRN/ITZN_2021_82_2_20