

Use of Elements of Augmented Reality in the Educational Process in Higher Educational Institutions

Viktoriya N. Taran
V.I. Vernadsky Crimean Federal University
Simpferopol, Russia, 298600
victoriya_yalta@ukr.net

Abstract

The widespread use of various gadgets by students, schoolchildren and even children of preschool age expands the possibilities of educational technologies through the visualization and virtualization of information and processes that are explained by this information. The reality created by gadgets, sometimes absorbs the user so that they can not distinguish between the invented and realized by computer technology environment from the natural. This feature should be used in training to improve its quality and increase its effectiveness, as well as for educational purposes. Combination of real environment and digital information is possible due to technologies of augmented reality. The article provides definitions of augmented reality; its properties are considered. The following types of augmented reality used in education are highlighted: learning applications (addition of teaching visualized information); books with the use of augmented reality; object modeling (drawings in engineering, architecture, construction, etc.); process simulation; games; skills training applications, such as aircraft piloting. The problem of material memorization, which is presented in the form of a pyramid of learning (or material memorization), is considered. The possibilities of introducing augmented reality into the educational process are analyzed and its positive and negative sides are revealed during training. Mandatory and undesirable elements of learning through the use of augmented reality are identified. It is shown that the use of augmented reality in teaching allows to achieve high results when combining modern information technologies and technical innovations with classical teaching methods, while taking into account psychological and pedagogical methods and means.

Keywords: Augmented reality; Information Technology; educational technologies; gadgets; interactive technologies; teaching.

Copyright 2019 for this paper by its authors.

Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

In: Jože Rugelj, Maria Lapina (eds.): Proceedings of SLET-2019 – International Scientific Conference Innovative Approaches to the Application of Digital Technologies in Education and Research, Stavropol – Dombay, Russia, 20-23 May 2019, published at <http://ceur-ws.org>

1 Introduction

Information technologies are developing so fast in the modern world that the lag one step threatens to reject both the user and the specialist for an entire era of new knowledge, capabilities, tools and software and technical implementations [Tar16]. Technologies are being developed, equipment supporting these technologies is being improved, and technical means are being modernized and optimized in terms of size, speed and functionality.

Today, every schoolchild owns the skills of online communication using social networks and various gadgets and devices. To use these skills is the task of a modern teacher, who can oppose empty pastime in the network to interesting and visual stories, which have the goal of not only presenting information, but also having a learning effect, i.e. aimed at understanding the information received, its synthesis and the formation of subsequent conclusions. As an incentive and motivation for learning (or effective learning), augmented reality can be provided with a skillful combination of technical, software and didactic teaching aids for both schoolchildren and students of various specialties and areas.

The teacher, in turn, applying e-learning, should master special software, had skills in the electronic learning environment, and use modern equipment for teaching students (computer global networks, web-cameras, etc.) [Tar18]. At the same time, the rational use of information resources in the implementation of educational programs has gradually become the main trend of modern education [Pan18].

Lecturers and professors involved in the education of future teachers need to have priority in this activities, as they have more experiences in innovative didactic approaches and they contribute significantly to the development of skills and knowledge regarding the use of ICT in learning process that future teachers must acquire during their studies. They have also significant indirect impact on gradual improvement of the quality of teaching and learning [Rug18].

It should be noted that regional universities have a huge shortage of resources (information, personnel, financial, hardware-technical, etc.), without which it is impossible to create special educational conditions for students [Panyu18].

2 Task

The purpose of this study is to analyze the possibilities of introducing augmented reality into the educational process and identifying its positive and negative consequences for students, as well as identifying mandatory and undesirable elements of learning through the use of augmented reality.

The widespread use of various gadgets by students, schoolchildren and even children of preschool age expands the possibilities of educational technologies through the visualization and virtualization of information and processes that are explained by this information. Virtual reality sometimes absorbs the user to such an extent that he cannot distinguish between the environment invented and realized by computer technologies from the natural one. This feature of virtual reality should be used in training to improve its quality and increase its efficiency, as well as for educational purposes [Tar18].

3 Learning Through Augmented Reality

3.1 The Concept Of "Augmented Reality"

It is required to include elements of interactivity or practical activities in the learning process to attract attention and retain it. This will instill interest in the subject, increase the learner's desire to receive new knowledge, and deepen existing ones. The technology of augmented reality is allowing you to interest new knowledge, show creativity, motivate for independent action and self-learning [Tar18a].

A prerequisite for the emergence of the category of augmented reality is the human capacity for imagination, the desire to add something non-existent or even impossible to this world and still feel the real world, that is, not to lose attachment to the "world of things" [Ale14].

For the first time, the term augmented reality was proposed by A. Sutherland in the 60s of the XX century in the process of developing with the students of Harvard University Sword of Damocles stereo glasses for displaying three-dimensional graphics, which were the prototype of augmented reality in its modern interpretation.

The concept of "augmented reality" was formulated still in 1990 by Thomas P. Caudell, but it has become widespread in the past few years.

Augmented reality can be represented as an environment that combines the physical world with the direct or indirect imposition of real-time digital data on it using innovative gadgets, computer devices, tablets, smartphones, helmets, stereo glasses, and software for them.

“Augmented Reality” (Augmented Reality - AR) is a new interactive technology that allows you to overlay computer graphics or textual information on real-time objects, this combining on the screen two initially independent spaces: the world of real objects around a person and the virtual world created on a computer [Kra14].

Augmented reality is a new way of accessing data: as the Internet has made information more context-sensitive (the user is offered information based on the information he has viewed), so augmented reality has made the information determined by environmental conditions (the information is offered to user based on external data about the world, such as geo-coordinates, visual images of objects). Augmented reality allows you to solve a wide range of tasks, providing a new user-friendly interface for interacting with the user [Koch16].

AR technologies allow a person to introduce really non-existent objects that are generated by a computer in three dimensions and freely place them in different ways in a real environment or technologically reproduced space [Ale14].

According to Dementieva A.V., Otkupchikova I.A., Reskova K.N. [Dem17] augmented reality is the technology of adding or introducing elements of virtual information into the real life of a person, displayed on the screen using technical means. Technologies of creation of augmented reality allow to erase the line between the surrounding and artificially created world.

In 1997, Ronald T. Azuma, in his study on various ways of using augmented reality, gave it a rather capacious and simple definition - this is a system that has the following properties [Mas16]:

- combines the virtual and real;
- interacts in real time;
- works on the basis of digital technologies and is located in three-dimensional space [Azu97].

Thus, we can say that the technologies of augmented reality change the reflection on the gadgets of reality surrounding us, superimposing digital information in the form of text, image or animation in real time on it.

3.2 Introduction Of Elements Of Augmented Reality In Learning

In the field of education and training in information and communication technologies, significant changes are taking place, connected with the adaptation of the educational process to new technological tasks [Kot18]. Modern information and communication technologies and pedagogical methods are used in classical education and in distance or online learning to increase the level of education of the population.

In general, the elements of online learning are used in the most leading foreign and Russian universities or “mixed education” is practiced. The list of IT-technologies used in education is constantly expanding, including through new social media and web 2 services. The number of implemented educational innovations is increasing [Pan18] as the use of elements of augmented reality is growing.

In view of the renewal of the goals and requirements of the standards of vocational education in higher education, there is a need to organize the learning process with the use of technologies that can provide not only the formation of a fundamental knowledge base, but also self-development of the individual, adaptation, ability to self-study [Kot15].

The relevance of the choice is determined by the following trends:

- emergence of various forms of open education;
- focus on the student-oriented concept;
- increasing academic mobility of students;
- enhancement variability, flexibility and differentiation of educational programs;
- implementation of individual educational routes;
- use of non-standard forms of educational process organization, going beyond a certain educational organization;
- review of technologies and methods of teaching, strengthening of cooperation ties and development of social partnership of educational organizations [Zen18].

For the student, augmented reality technology creates an effect of presence, thereby erasing the line between the real and virtual world, which allows you to master scientific knowledge easily and in a memorable form. It attracts a person from a psychological point of view, because his attention is intensified due to which the attractiveness of the material being studied increases.

The rendered virtual information is synchronized in real time with the space surrounding the user, due to which a complete immersion into augmented reality occurs, which leads to an improved perception of the training material. For example, it is possible to see in the smallest details monuments of architecture and architecture, or

their condition before restoration and after (or the state of these monuments during World War II), to examine museum exhibits, to see and study geographical objects, their relief, structural features, etc. p., to conduct physical or chemical experiments, for which, in real conditions, special expensive instruments and reagents are necessary, as well as to consider geometrical simple solutions when solving problems in 3-D objects, thereby reducing the distortion of the image of a two-dimensional projection of a three-dimensional object, etc.

AR technologies enable learners to manage objects of augmented reality, view them from different angles, rotate, move them, change scale - this gives a great impetus to the development of spatial thinking, allows us to perceive the discipline being studied more fully and more deeply, thereby improving the quality of the knowledge gained.

Augmented reality helps to correct the insufficiently formed spatial thinking in students, which is formed in a student under 14 years of age. With the modern pace of development and the speed of information transfer, a young person simply does not have enough time to realize the knowledge gained and to form his own experience, but mostly uses only visible, lying on the surface facts and easily accessible surface information without looking deeply communication without drawing conclusions and consequence. However, without these important stages of learning, it is impossible to form a specialist who is ready to make responsible decisions. It is the ability to summarize information and draw conclusions, to predict or predict possible scenarios for the development of a process that forms the future high-class specialist, in whatever area he works. Visualization when teaching spatial objects, which previously could only be seen in the picture, i.e. in a two-dimensional image, allows you to see the "bottlenecks" or poorly understood details, which helps to draw the right conclusions and provide for measures to ensure the reliability of the object or process.

The following types of augmented reality used in education can be called:

- educational applications (addition visualized information for learning);
- books with the use of augmented reality, forming the connection between the virtual and the physical world;
- object modeling (used for visualization of drawings in engineering, architecture, construction, etc.);
- simulation of processes (used to simulate the flow of processes in real time);
- games;
- training applications (for practicing skills, for example, piloting aircraft).

According to the authors [9], the problem in education lies in the methods of learning and the level of memorization of the material, which is presented in the form of a pyramid of learning (or memorization of the material), and has the following form:

- lectures – 5 %,
- reading – 10 %,
- audio, video training – 20 %,
- to the demonstration, the show – 30 %,
- discussion, dispute – 50 %,
- practical activities – 75 %,
- student learning by other students – 90 % (Fig. 1).

Thus, only up to 20% of children are able to perceive information in a "dry" form, i.e. in the classical form in which it is presented in educational institutions. For the remaining 80% of children, additional techniques and methods are needed, including interactive teaching methods, for example, perception of information based on augmented reality.

The task of the teacher is to give primary knowledge on the subject, to push, to interest the learner in self-information. Motivating to learn is the most difficult problem. To solve it, there is a search for new methods, ways, methods of training, but the main thing is always the interest of the student.

Achieving full involvement in the learning process contributes to increased motivation and success in gaining knowledge [Sek17]. Full involvement can occur through practical activities, project activities, discussion and debate, as well as through self-study and help in teaching comrades. No less important is the moment of primary involvement, which occurs at the stage of familiarization with the material, it is at this moment that it helps to connect all types of memory (auditory, visual and active) using augmented reality, which connects the student's emotions (surprise, delight from what he saw, desire do something yourself). After all, on emotions or on emotional level, memorization of information occurs many times faster, and not only short-term memory is included, but also long-term.

Information resources combining objective and virtual reality not only amaze the imagination, but also develop it, push the boundaries of the conceivable, create a new, unusual and "improved" world, generate a new type of

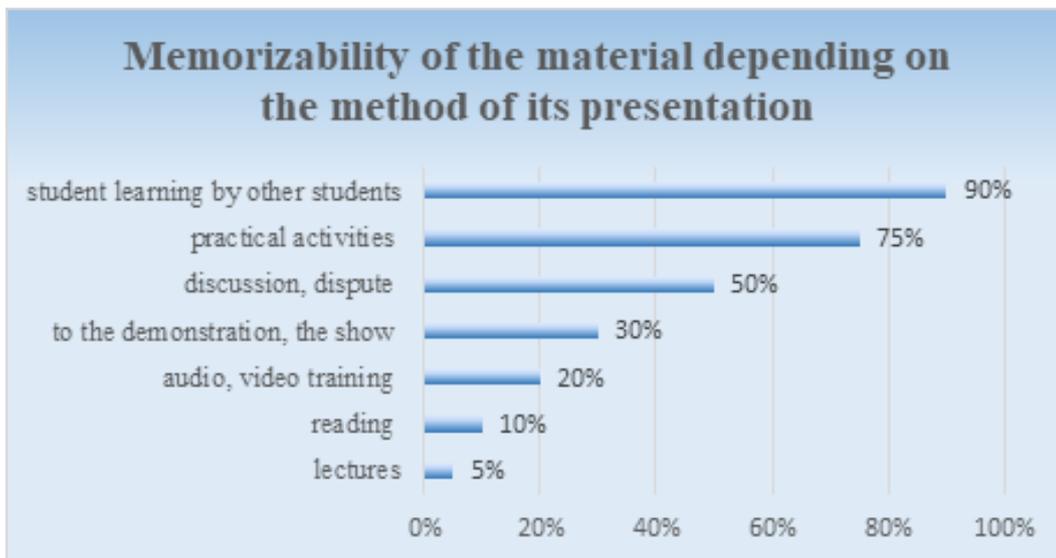


Figure 1: Memorizability of the material depending on the method of its presentation

reality: “mediated” reality and new information that is used in an increasing number of diverse areas of activity [Rya16].

Modern information technologies imply the availability of new competencies among users, obligatory for an educated person, significantly different from classical education, which is based primarily on erudition, a set of knowledge stored by human memory. For example, when looking at a certain specific building, an educated person can say what kind of building it is, as well as when and by whom it was built. Now it is especially important to be able to use technology to search for this information, and the faster the user navigates the Internet space, the better, and applications with augmented reality in this context look particularly promising.

Schoolchildren and students easily master new information technologies and widely use them in their daily lives, which is why the use of modern information and communication technologies in training is especially important and actual.

Along with the following information educational technologies: Internet-oriented educational technologies, distance education technologies, media education technologies, e-learning technologies, SMART education technologies [Zen14] - augmented reality technologies should also be mentioned.

The use of augmented reality in our country has not yet reached the level of its application abroad, which includes: advertising, industry, entertainment (games), education, military technology, simulators, medicine.

At the present stage, the use of augmented reality in the Russian Federation takes up to 50% in the advertising and exhibition sphere, up to 30% in games and entertainment, and only about 10% in education. In other areas, the use is so small that it is too early to talk about augmented reality, but its introduction into all spheres of human life is an inevitable process.

3.3 Advantages And Disadvantages Of Learning When Using Elements Of Augmented Reality

The emergence of new space recognition technologies and the growth of the production of wearable computers (wearable devices), of course, are stimulating factors for the development of augmented reality, with many foreign researchers calling AR technology one of the main educational trends in the coming decade [Zel14].

So, let us dwell on the advantages and disadvantages of this technology - Augmented Reality technology.

On the one hand, the advantages of augmented reality include the following:

- interest in the material under study is increasing, there is a desire for self-learning and knowledge of the new;
- the quality and effectiveness of training is enhanced by visibility and visualization of objects and processes;
- spatial thinking develops;
- during training, interactivity prevails and there is a focus on the activities of the student;
- ease of use of applications attracts both trainees and teachers;
- it is possible to study a large amount of information in less time;

- student's surprise effect due to the connection of emotions, that is, memorization happens better and remains in memory longer.

On the other hand, the disadvantages of augmented reality include the following:

- lack of a unified educational platform;
- there is a need to develop special applications;
- the variety of available applications makes it difficult to choose a universal tool for reading or presenting information;
- for use, you must have the appropriate technical means: smartphones, tablets, helmets, mittens, glasses, lenses, etc., which is an insurmountable limitation for some segments of the population; - limiting the visual presentation of information by the user's device screen;
- marker recognition depends on the practical skills of the user and the technical characteristics of the reader, for example, the lighting of the object, the angle at which the user directs the camera, as well as the quality of the camera itself.

Thus, augmented reality has both advantages and disadvantages, but, in spite of everything, the development of augmented reality technologies cannot be stopped, they enter our lives widely and everywhere, and, therefore, they must be applied using the possibilities of visualization and connection of the real environment and virtual digital space, immersing the user in the learning process.

4 Directions For Using Augmented Reality Or Refusing To Use It In Training

After discussing the advantages and disadvantages of introducing elements of augmented reality into the learning process, conclusions should be made about using or not using AR technologies. So, what opportunities can and should be used when training.

Second, adding interactivity to learning. In the process of learning, you can independently set the transformation parameters of the object of study. This may be the date and definition of the appearance of the architectural monument on this date, there may be a change in scale depending on the distance to the object. Or it can be an independent choice of the point of view on the object (a monument, a geometric three-dimensional image, a relief, etc.).

Third, the creation of dynamic objects and processes. Due to the transformation of the object in real time, there are changes in its appearance, shape, color, and also the structure, properties and quantitative indicators can change, which are not possible to observe in ordinary life.

What should be discarded when using technologies of augmented reality.

First, it is impossible to insist on the need for students to acquire the appropriate gadgets and software applications. Each family has its own financial capabilities. When teaching, the application and display of the results of the augmented reality presentation must come from the teacher or the educational institution must be equipped with the appropriate equipment.

Secondly, it is impossible to focus only on the display and demonstration of an object or process. There should be elements of practical learning, i.e. there should be activities aimed at obtaining skills and abilities, and it is also necessary to include problematic questions and their discussion.

Thirdly, it is impossible to substitute communication with the teacher with communication with gadgets. The most effective training only when learning "eye to eye." The teacher's lively speech, his being in love with the stated material convinces the student of the absolute need to master this material, to learn even more, in order to obtain the approval of the teacher.

The general idea of using augmented reality is shown in Fig.2.

Thus, in each specific case, methods and ways of teaching should be correlated with the goal set during training, in order to choose the most modern technologies that meet the pedagogical, developmental and training objectives of the lesson. Undoubtedly, the teacher, keeping up with the times, will look for and use various techniques, including elements of augmented reality.

Quality education is possible only in a new educational environment, focused on the use of information and communication technologies. Unfortunately, the majority of teachers in modern universities still have a number of difficulties in using new technologies in their professional activities and have little idea how these opportunities can be used in educational practice to organize basic educational activities [Pan16].

The process of virtualization of reality leads to a significant expansion of the subject and non-object boundaries of culture, generating new sense-forming centers of being, changing lifestyles and a scale of priorities [Ale14] including changing the process of learning and acquiring new knowledge and competencies.

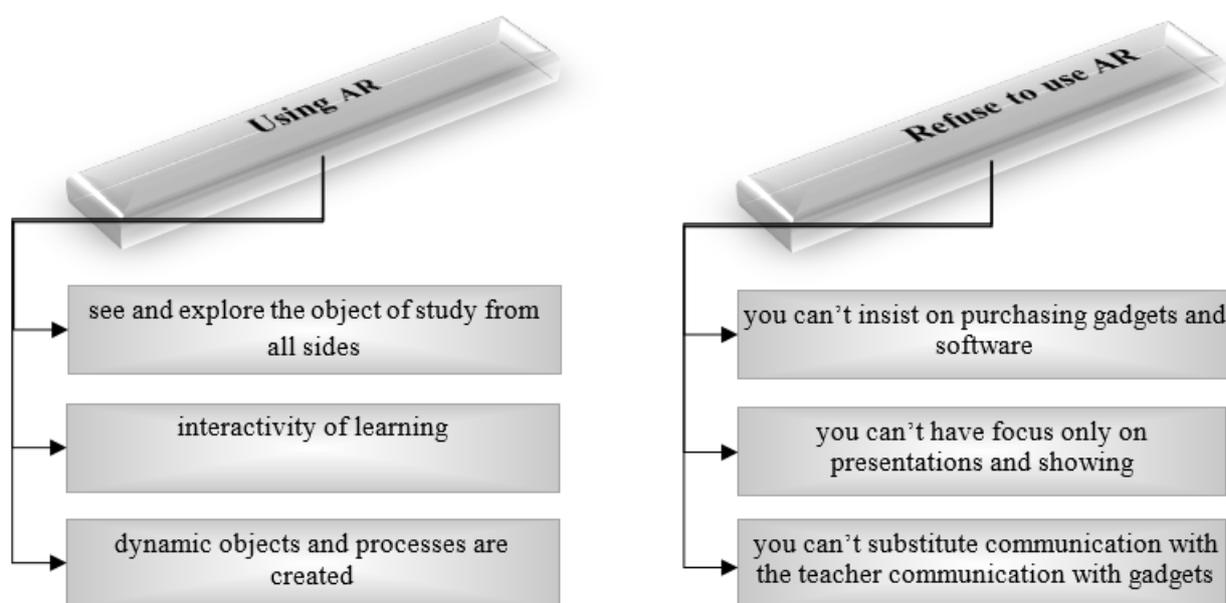


Figure 1: What opportunities can and should be used when learning with the help of augmented reality and from what should be discarded

Each teacher decides for himself whether or not to use technological innovations such as augmented reality, virtual reality, information and communication technologies, web quests, webinars, various forms and distance learning methods. But at the same time, it must be remembered that the task of higher education is not only to give knowledge, to form skills and abilities, as well as competences, but the main thing is to teach how to learn, i.e. to give a start in life to a professional who is not afraid of new tasks, is able to creatively solve any problem and have a creative approach to non-standard situations. Such experts will help to raise the economy and implement national development programs and road maps.

Undergraduates in the process of training in a pedagogical university create practical materials that are the most important way to develop their professional competence, and their use in educational institutions clearly demonstrates the relevance of this kind of intellectual product and effective interaction of pedagogical science with the general education system [Vez16].

5 Conclusion

Thus, the use of augmented reality when learning allows you to achieve high results, while you should skillfully combine modern information technologies and technical innovations with classical teaching methods, without neglecting psychological and pedagogical methods and tools.

In general, we can say that today the DR technology in education is at the stage of its formation, and, given the prospects for their development, it is necessary to carry out both foreign experience analytics and educational experiments with augmented reality in domestic schools and universities [Zel14].

Modern enterprises are in urgent need of an influx of young mobile personnel, that is explained by the country's new course for the implementation of the National Technology Initiative as one of the priorities of state policy, and we see the main task in creating conditions for the training of future personnel, corresponding to state priorities for the development of science and technology, able to develop in their hometown, thereby increasing its economic potential [Zen18].

References

- [Tar16] V.N. Taran. Analiz kompetensiy professorsko-prepodavatel'skogo sostava pri podgotovke IT-spetsialistov [Analysis of the competencies of the faculty in the preparation of IT-specialists] // Sovremennyye informatsionnyye tekhnologii i IT-obrazovaniye: mezhdunarodnyy nauchnyy zhurnal. 2016. T. 12 (4), - S. 20-24.

- [Tar18] V.N. Taran. *Primeneniye dopolnennoy real'nosti v obuchenii* / V.N. Taran // *Problemy sovremennogo pedagogicheskogo obrazovaniya*. Ser. : Pedagogika i psikhologiya. Sb. stat'i. - Yalta: RIO GPA, 2018. - Vyp. 60. - CH.II. - pp. 433-437.
- [Pan18] O.P. Pankratova, E.A. Konopko, R.M. Nemkov, O.S. Mezentseva. The preparation of a modern Computer Science teacher with the help of resource-saving technologies and Green IT implementation// *Integrating Research Agendas and Devising Joint Challenges International Multidisciplinary Symposium ICT Research in Russian Federation and Europe*. 2018. P. 222-228.
- [Rug18] J. Rugelj, M. Zapušek. Innovative and flexible forms of teaching and learning with information and communication technologies. In: *Education and research in the information society: proceedings*. Sofia: Institute of Mathematics and Informatics Bulgarian Academy of Sciences, 11-20
- [Panyu18] S.V. Panyukova, G.G. Saitgalieva, V.S. Sergeeva. Establishing Network Interaction between Resource Training Centers for People with Disabilities and Partner Universities. *Psychological Science and Education*. 2018. Vol. 23, no. 2. pp. 7-18.
- [Tar18a] V.N. Taran. Criteria of Quality for Professional Training of Highly Qualified Personnel in the IT Industry. In: *2018 IEEE XVII Russian Scientific and Practical Conference on Planning and Teaching Engineering Staff for the Industrial and Economic Complex of the Region (PTES)* pp. 47-50. DOI: 10.1109/PTES.2018.8604267
- [Ale14] L.D. Alexandrova. Opyt filosofskogo osmysleniya "dopolnennoy real'nosti" v ontologicheskom kontinuumе "virtual'nost' - real'nost'" [The experience of philosophical understanding of "augmented reality" in the ontological continuum "virtuality - reality"] // *Bulletin of the Chelyabinsk State Academy of Culture and Arts*. 2014. N4 (40). P. 59-63.
- [Kra18] Yu.A. Kravchenko, A.A. Lezhebokov, S.V. Pashchenko. Osobennosti ispol'zovaniya tekhnologii dopolnennoy real'nosti dlya podderzhki obrazovatel'nykh protsessov // *Otkrytoye obrazovaniye*. 3. 2014. S. 49-54. URL: <https://cyberleninka.ru/article/n/osobennosti-ispolzovaniya-tehnologii-dopolnennoy-realnosti-dlya-podderzhki-obrazovatelnyh-protsessov> (data obrashcheniya: 28.08.2018)
- [Koch16] A.A. Kochkin, S.N. Kalashnikov, S.Yu. Krasnoperov. Stsenariy vzaimodeystviya v programmnykh obrazovatel'nykh resursakh s interfeysom dopolnennoy real'nosti // *Internet-zhurnal NAUKOVEDENIYe Tom 8, 5 (2016)* <http://naukovedenie.ru/PDF/11TVN516.pdf> (dostup svobodnyy) (data obrashcheniya: 25.09.2018).
- [Dem17] A.V. Dement'yeva, I.A. Otkupshchikova, K.N. Res'kov. Dopolnennaya real'nost' v uchebnom protsesse // *Nauchnoye soobshchestvo studentov: Mezhdistsiplinarnyye issledovaniya: sb. st. po mat. XLII mezhdunar. stud. nauch.-prakt. konf. 7 (42)*. URL: [https://sibac.info/archive/meghdis/7\(42\).pdf](https://sibac.info/archive/meghdis/7(42).pdf) (data obrashcheniya: 23.08.2018)
- [Mas16] Ye.A. Maslov, A.A. Khaminova. Vnedreniye sovremennykh tekhnologiy virtual'noy i dopolnennoy real'nosti v kreativnoy industrii: tendentsii i problemy // *Gumanitarnaya informatika*. 2016. Vyp. 10. S. 35-46. DOI: 10.17223 / 23046082/10/4
- [Azu97] R. T. Azuma. *A Survey of Augmented Reality* / R. T. Azuma // *Teleoperators and Virtual Environments* 6, 4. - 1997. - August. - P. 355-385.
- [Kot18] Ye.Ye. Kotova. Training specialists in the ICT industry based on a client-oriented approach. In: *2018 IEEE XVII Russian Scientific and Practical Conference on Planning and Teaching Engineering Staff for the Industrial and Economic Complex of the Region (PTES)* pp. 119-122.
- [Zen18] S. Zenkina, O. Pankratova, E. Konopko, A. Ardeev. Model of organization of network project-research students activities in collaboration with city-forming enterprises// *Integrating Research Agendas and Devising Joint Challenges International Multidisciplinary Symposium ICT Research in Russian Federation and Europe*. 2018. P. 290-296.

- [Kot15] Ye.Ye. Kotova. Imitation studies of the process of training specialists using blended learning technologies (Blended Learning Technology) // Planning and providing training for the industrial-economic complex of the region. 2015. Vol. 1. pp.252-258.
- [Sek17] V.D. Sekerin, A.Ye. Gorokhova, A.A. Shcherbakov, Ye.V. Yurkevich. Interaktivnaya azbuka s dopolnennoy real'nost'yu kak forma вовлечения детей в образователь'nyy protsess // Otkrytoye obrazovaniye. T. 21. N5. 2017. S. 57-62.
- [Rya16] N. Ryabtseva Modern information technologies and the human intellectual world: "from augmented reality to augmented human" // Cognitive modeling: Proceedings of the Fourth International Forum on Cognitive Modeling. In 2 parts. 2016. p. 412-421.
- [Zen14] S.V. Zenkina, O.P. Pankratova. Ispol'zovaniye informatsionnykh obrazovatel'nykh tekhnologiy v usloviyakh vnedreniya novykh standartov obshchego obrazovaniya / Informatika i obrazovaniye. 2014. N7 (256). P. 93-95.
- [Zil14] N.N. Zil'berman, V.A. Serbin. Vozmozhnosti ispol'zovaniya prilozheniy dopolnennoy real'nosti v obrazovanii. Natsional'nyy issledovatel'skiy Tomskiy gosudarstvennyy universitet. URL: http://huminf.tsu.ru/wordpress/wp-content/uploads/serbin_va-zilberman_nn/2014/
- [Pan16] O.P. Pankratova, E.A. Konopko, K.A. Katkov. The Experience of Using Cloud Technologies in Creating the Information Educational Environment of a University / Problems of Modern Teacher Education. 2016. N53-2. Pp. 143-149.
- [Vez16] T.G. Vezirov, E.A. Kostina. Educational Web-Technologies in Training Bachelors and Masters of Pedagogical Education // Bulletin of Novosibirsk State Pedagogical University. 2016. N4 (32). Pp. 39-49.