UNIVERSITY OF NOVI SAD
TECHNICAL FACULTY
"MIHAJLO PUPIN"
ZRENJANIN

ITROCONFERENCE[11]

INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

ITROCONFERENCE[11]

INFORMATION TECHNOLOGY AND EDUCATION DEVELOPMENT

PROCEEDINGS

ZRENJANIN, Oktobar 2020

Publisher and Organiser of the Conference:
University of Novi Sad, Technical faculty „Mihajlo Pupin", Zrenjanin, Republic of Serbia

For publisher:
Dragica Radosav, Ph. D, Professor,
Dean of the Technical faculty „Mihajlo Pupin", Zrenjanin, Republic of Serbia

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Circulation: **50**

ISBN: 978-86-7672-341-6

CIP - Каталогизација у публикацији
Библиотеке Матице српске, Нови Сад

37.01:004(082)
37.02(082)

INTERNATIONAL Conference of Information Technology and Development of Education ITRO (11 ; 2020 ; Zrenjanin)

Proceedings of papers [Elektronski izvor] / XI International Conference of Information Technology and Development of Education ITRO 2020 = Zbornik radova / XI međunarodna konferencija Informacione tehnologije i razvoj obrazovanja ITRO 2020, Zrenjanin, October 2020. - Zrenjanin : Technical Faculty "Mihajlo Pupin", 2020. - 1 elektronski optički disk (CDROM) : tekst, graf. prikazi ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Elektronska publikacija u formatu pdf opsega 265 str. - Bibliografija uz svaki rad.

ISBN 978-86-7672-341-6

a) Информационе технологије -- Образовање -- Зборници б) Образовна технологија – Зборници

COBISS.SR-ID 26470409

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With this publication, the CD with all papers from the International Conference on Information Technology and Development of Education, ITRO 2020 is also published.

Review: The use of Augmented and Virtual Reality in Education

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Abstract – The COVID-19 pandemic has a severe impact on education all over the world. The closures of educational institutions affected teaching and learning processes and had an impact on students' motivation and engagement. In this context, AR/VR technology can provide assistance to students and support for educators. This paper presents a review of literature on augmented and virtual reality in educational settings in the last 5 years. In total 23 research studies were included in the study. Target group, field of education, reported advantages, limitations and concerns have been investigated and reported. The findings showed that students' learning can benefit both technologies by increasing engagement, motivation, collaboration and learning achievement.

I. INTRODUCTION

The lockdowns in response to COVID-19 have interrupted conventional schooling in almost every country in the world. To keep the children learning, countries have been implementing various digital tools and application. During this period, e-learning platforms have been widely used for providing teaching and learning activities. However, in some areas where practical training is required, online learning platforms are not sufficient for acquiring the required knowledge. One opportunity on the horizon is expanding the use of immersive computing technologies, like augmented, virtual or mixed reality (AR/VR/MR), that create new modes for users to experience digital content.

These technologies are affordable and readily available. They can help us transform our immediate surroundings into learning, work and entertainment spaces. Learning in an AR/VR environment has been found to increase recall [1], to develop muscle memory for specific tasks [2] to increase student learning motivation and contribute to improved academic achievement [3, 4].

In the current COVID-19 scenario, AR/VR technologies are extremely useful in providing remote one-to-one scalable training and education, especially when group training or lectures are no longer viable options. They strive to empower energy of the classroom, energize connection to one another and find new ways to deepen experiences. For both educators and students, AR/VR are quickly proving to have unique benefits, many of which are incredibly well suited to this moment.

A considerable amount of literature has been published in AR/VR applications in educational contexts for a wide variety of learning domains and level of education. The aim of this article is to review literature regarding the use of augmented and virtual reality in educational settings, published in last 5 years. All articles are categorized according to target groups, field of education, reported advantages, limitations and concerns.

II. BACKGROUND

Augmented reality (AR) combines real and virtual world, supplementing the real world with computer-generated virtual objects in real-time [5, 6]. AR acts as a bridge between real world and virtual environment by providing synchronous interaction. It uses pre-determined target points in real world by connecting virtual objects and interpreting the results through certain programs. AR is enriching user's perception of the reality rather than totally replacing it [7], like in the case of the virtual reality.

In virtual reality (VR) the user is completely immersed inside a synthetic environment and can not perceive the real world and the real environment that surrounds him/her (the real world is shut out and the user steps into a digital world).

Mixed reality (MR) brings together real world and digital elements, breaking down basic concepts between real and imaginary. In MR, user can interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. The Milgram's Reality-Virtuality continuum [8] clearly shows the location of MR as well as relation between a real environment, AR and a VR environment (Fig. 1).

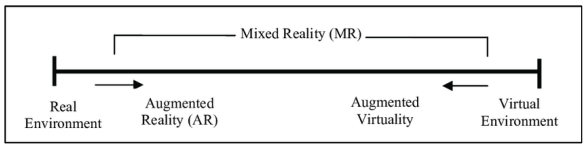

Figure 1. Reality-Virtuality continuum

III. METHOD

In this review study the Arksey and O'Malley's (2005) five-stage framework is utilized. The five stages of this framework are: (1) identifying research questions, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) summarizing and reporting the results.

A. Identifying research questions

The aim of this review was to explore the literature regarding the use of AR/VR application in educational scenarios. In order to capture the relevant research studies, following research questions were posed to guide the research:

- What technologies are being used?
- Which target groups are covered with the research articles?
- Which fields of education are covered with the research articles?
- What are reported advantages of using AR/VR applications in educational setting?
- What are reported limitations and concerns of using AR/VR applications in educational setting?

B. Identifying relevant studies

To cover a broad range of studies regarding the use of AR/VR in education, the search was performed using the following keywords: "Augmented reality", "AR", "Virtual reality", "VR". The literature source was the Science direct and Eric databases. Relevant papers were considered only papers published in last 5 years (from 2016 to August 2020). This was considered appropriate due to the rapid technology development and the wider use of AR/VR applications in education.

C. Study selection

Twenty-three research studies were selected and included in this review. These articles were selected according to the following inclusion/exclusion criteria.

Inclusion criteria:

- Papers published in the last 5 years;
- Studies that are carried out in formal education context;
- Studies in which an evaluation with end users has been conducted;
- Studies where an AR/VR application is integrated with or applied in teaching-learning process, and learning outcomes are reported.

Exclusion criteria:

- Papers explaining some commercial application, present on market, but not scientifically based;
- Previews of thesis and dissertations, or review papers;
- Papers containing only methodology, platform or framework explaining the approach;
- Papers explaining only the design of AR/VR application;
- Studies that are carried out in informal or non-formal learning contexts.

C. Charting the data

A brief summary of all selected articles is presented in Table 1.

TABLE 1. STUDIES INCLUDED INTO REVIEW

Authors	**Title**	**Application type used in the study**
Harun, Neha Tuli , Archana Mantri	"Experience Fleming's rule in Electromagnetism Using Augmented Reality: Analyzing Impact on Students Learning"	AR
Bhanu Charma, Archana Mantri	"Assimilating Disruptive Technology: A New Approach of Learning Science in Engineering Education"	AR (marker based)
Guido Bozzelli, Antonio Raia, Stefano Ricciardi, Maurizio De Nino, Nicola Barile, Marco Perrella, Marco Tramontano, Alfonsina Pagano, Augusto Palombini	"An integrated VR/AR framework for user-centric interactive experience of cultural heritage: The ArkaeVision project"	AR and VR
Michelle Aebersold, Terri Voepel-Lewis, Leila Cherara, Monica Weber, Christina Khourie , Robert Levine, Alan R. Tait	"Interactive Anatomy-Augmented Virtual Simulation Training"	AR

Jeferson Arango-López, Carlos C. Valdivieso, Cesar A. Collazos, Francisco Luis Gutiérrez Vela, Fernando Moreira	"CREANDO: Tool for creating pervasive games to increase the learning motivation in higher education students"	AR (marker based)
Jared A. Franka , Vikram Kapilaa	"Mixed-reality learning environments: Integrating mobile interfaces with laboratory test-beds"	AR (marker based), MR
Mark Durham, Benjamin Engelb , Thomas Ferrill, Jaron Halford, Tejinder P. Singh, Michael Gladwell	"Digitally Augmented Learning in Implant Dentistry"	VR
Dilara Sahina and Rabia Meryem Yilmazb	"The Effect of Augmented Reality Technology on Middle School Students' Achievements and Attitudes Towards Science Education"	AR
Lissette Lopez-Faican, Javier Jaen	"EmoFindAR: Evaluation of a mobile multiplayer augmented reality game for primary school children"	AR (location based)
Ayman F.A. Foad, MD	"Comparing the use of virtual and conventional light microscopy in practical sessions: Virtual reality in Tabuk University"	VR
Nikolche Vasilevski and James Birt	"Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environment"	AR and VR
Garcia-Bonete, Maria-Jose; Jensen, Maja; Katona, Gergely	"A Practical Guide to Developing Virtual and Augmented Reality Exercises for Teaching Structural Biology"	AR and VR
Sara K. Sweeney, Phyllis Newbill, Todd Ogle & Krista Terry	"Using Augmented Reality and Virtual Environments in Historic Places to Scaffold Historical Empathy"	VR
Stotz, Megan; Columba, Lynn	"Using Augmented Reality to Teach Subitizing with Preschool Students"	AR
Christian Moro Zane Štromberga Athanasios Raikos Allan Stirling	"The effectiveness of virtual and augmented reality in health sciences and medical anatomy"	AR and VR
Cihak, David F.; Moore, Eric J.; Wright, Rachel E.; McMahon, Don D.; Gibbons, Melinda M.; Smith, Cate	"Evaluating Augmented Reality to Complete a Chain Task for Elementary Students with Autism"	AR (marker based)
Baran, Bahar; Yecan, Esra; Kaptan, Burak; Pasayigit, Ozan	"Using Augmented Reality to Teach Fifth Grade Students about Electrical Circuits"	AR
Liou, Wei-Kai; Bhagat, Kaushal Kumar; Chang, Chun-Yen	"Beyond the Flipped Classroom: A Highly Interactive Cloud-Classroom (HIC) Embedded into Basic Materials Science Courses"	AR and VR
Nasser Alalwana, Lim Chengb , Hosam Al-Samarraiec, Reem Yousefd, Ahmed Ibrahim Alzahrania, Samer Muthana Sarsam	Challenges and Prospects of Virtual Reality and Augmented Reality Utilization among Primary School Teachers: A Developing Country Perspective	AR and VR
Sáez-López, José-Manuel; Sevillano-García, M. Luisa; Pascual-Sevillano, M. Ángeles	"Application of the Ubiquitous Game with Augmented Reality in Primary Education"	AR
Taskiran, Ayse	"The Effect of Augmented Reality Games on English as Foreign Language Motivation"	AR
Buchner, Josef; Zumbach, Jörg	"Promoting Intrinsic Motivation with a Mobile Augmented Reality Learning Environment"	AR
Vega Garzón, Juan Carlos; Magrini, Marcio Luiz; Galembeck, Eduardo	"Using Augmented Reality to Teach and Learn Biochemistry"	AR

All articles were categorized according to field of education, reported advantages, limitations and concerns in educational setting.

"Target group" category refers to the level of education of participants in the experiments in which the study of AR/VR in education was carried out, or level of education for which the AR/VR application is intended. The following target group were identified: early childhood, primary school, secondary school, high school and all levels of

education. Fig. 2 shows the results of this classification.

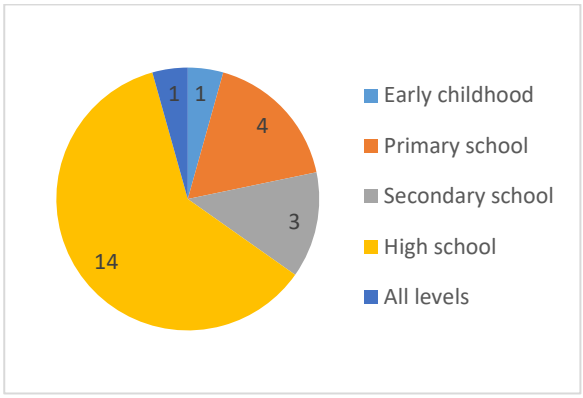

Figure 2. Target groups of reviewed articles.

Results show that AR/VR technology has been mostly carried out in high school education. On the other hand, all other target groups, especially early childhood education, need further research regarding the use of this technology in education.

Regarding "Fields of education", analyses show that "engineering studies" is the most explored field of education, while "math", "chemistry" and "foreign language" are the least explored. Fig. 3 summarizes the results regarding the use of AR/VR by field of education.

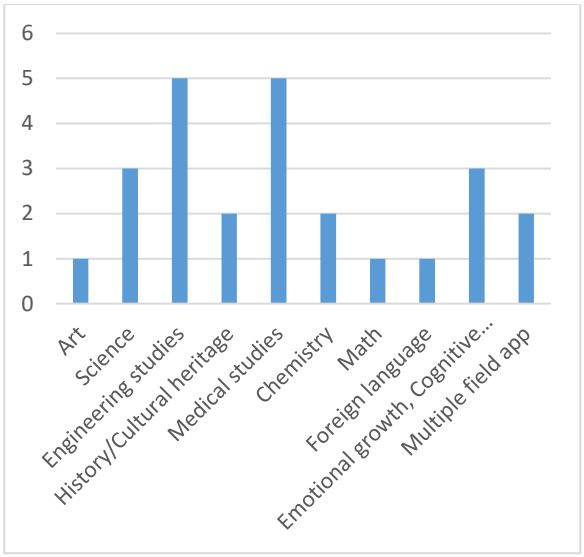

Figure 3. Using AR/VR by field of education.

Another category analyzed in this review is "Reported advantages" of AR/VR in educational settings. Since one study can report more than one advantage, each study can meet more than one sub-category. Table 2 shows the results of the reported advantages identified in the analyzed studies.

TABLE 2. REPORTED ADVANTAGES OF AR/VR IN EDUCATIONAL SETTINGS.

Advantages (sub-categories)	**Number of studies**	**Percentage (%)**
Engagement	5	21,74
Motivation	6	26,09
Interest	5	21,74
Learning Achievement	8	34,78
Improved memory	4	17,39
Enjoyment	9	39,13
Interaction with the objects/environment	4	17,39
Positive Emotion	3	13,04
Perception	3	13,04
Low anxiety	3	13,04
Communication/ collaboration	9	39,13
Cost saving	2	8,70
Ease to use	2	8,70

From the results, it can be seen that the major advantages reported in the studies are: "Communication/collaboration", "Enjoyment" and "Learning achievement". The results show that AR/VR is a promising technology for improving learning achievement and provide new opportunities for students to communicate and collaborate with the teachers and with each other. This technology also helps students enjoy the learning process.

Category "Limitations/Concerns" aims to identify the reported limitations and concerns of AR/VR technology when used in educational settings. It should be noted that not all articles reported limitations. Table 3 summarizes these results.

Studies included in this review outlined several limitations/concerns regarding the use of AR/VR applications in education. The most reported limitation/concerns are "Technical issue", followed by "Small sample size" and "Motion sickness/dizziness".

TABLE 3. REPORTED LIMITATIONS/CONCERNS OF AR/VR IN EDUCATIONAL SETTINGS.

Limitations/Concerns	Number of studies	Percentage (%)
Motion sickness/ dizziness	4	17,39
Small sample size	5	21,74
Technical issues	6	26,09
Short evaluation time	3	13,04
Complexity	1	4,34
Not specified in the study	8	34,78

D. Summarizing and reporting the results

A considerable amount of literature has been published in AR/VR application in various domains. However, the state of current research in AR/VR for education domain is still in its infancy. The research in this field should continue and should be addressed to discover the affordances of AR/VR applications in education.

In total 23 studies were analysed in this review, by using the content analysis method. Analysis shows that AR/VR technology has been mostly carried out in high school education [9, 10, 12, 13, 14, 15, 18, 19, 20, 21, 23, 26, 29, 31], with the highest percentage in medical and engineering studies. This technology enables students better visualization and superior educational interface as compared with their standard training methods [12], improves students' mental map [15], significantly improves their level of content knowledge [14, 15, 18], enhanced engagement, enjoyment, motivation and participation [19, 23, 25], improves students' outcome [9], reduces the subjectivity of assessment process and determine student progress [31]. In primary school AR/VR technology was used to provide emotional growth, cognitive skills and social interaction [17], to promote exploratory behavior and develop a positive attitude [27 and to learn new skills [24]. AR/VR applications positively affects students' achievement throughout the learning process also in secondary education [16]. This innovative technology facilitates students' success making the course and its content more exciting. Moreover, students actively participate in the lessons and ask the teacher more questions, they are more motivated and eager to use this technology [16, 25, 30].

Most of the studies included in this review revealed the fact that the use of AR/VR technology enhances learning achievement, which is in line with the previous studies [32, 33, 34]. This technology promotes active learning and turns passive learners into active learners by engaging them in interactive assignments [26]. It succeeds to provide better learning achievement [16, 28, 30], foster collaboration [17, 29, 31], increase engagement [16, 17, 19, 23] and motivation within the scale interest/enjoyment [10, 19, 23, 30].

Although AR/VR technology in formal education has many advantages and is valuable for desired educational outcomes, there are some technical problems that need to be overcome. Vasilevski and Birt [19] reported negative experiences with the technology, mainly with the control. There were also some concerns about the devices overheating, the discomfort and weight of the headsets [19]. Some participants found that the touchscreen devices were too sensitive and unintuitive to control, while virtual object behaved unrealistically [20]. A potential issue that can have an impact on learning experiences and assessment results when using VR is cybersickness, which can result in motion sickness, dizziness, disorientation, discomfort, headache, fatigue, difficulty concentrating, and problems with vision [11, 19, 23]. This was one of the major concerns reported in the studies. The other important limitation that was pointed out is small sample size (number of participants involved in the evaluation process) [12, 19, 23]. The lack of an appropriate sample size in which AR/VR applications are integrated with teaching-learning processes limits the researchers to generalize their findings. Therefore, future studies need to be conducted with a larger number of participants, in order to confirm the research findings.

IV. CONCLUSION

AR/VR technology has attracted attention in education field with its ability to allow interaction with virtual objects in real environment, thus enabling learning by doing. In a period of world pandemic, when the whole educational process is transferred online, AR/VR technology can create a physical engagement between the learner and their environment. It engages the student's senses and enhances learning by immersing them in a world rich in both information and experience.

The aim of this article is to review literature regarding the use of augmented and virtual reality in educational settings, published in last 5 years. We consider factors such as target groups, field of education, reported advantages and limitations/concerns of using AR/VR technology in education. The findings of this review illustrated a set of studies that provide evidence of increased learning achievement, students' engagement,

motivation, and collaboration through the educational environments that are enriched with AR/VR applications. However, some concerns and limitations regarding these technologies were reported, which need to be minimized and overcome in the future research.

REFERENCES

[1.] Krokos, E., Plaisant, C. & Varshney, A. (2019). Virtual memory palaces: immersion aids recall. Virtual Reality 23, 1–15.
[2.] Koutitas, G., Smith, S. & Lawrence, G. (2020). Performance evaluation of AR/VR training technologies for EMS first responders. Virtual Reality.
[3.] M. B. Ibáñez, Á. Di Serio, D. Villarán, and K. C. Delgado, (2014). Experimenting with electromagnetism using AR: impact on flow student experience and educational effectiveness. Computers and Education, vol. 71, pp. 1–13.
[4.] T. H. C. Chiang, S. J. H. Yang, and G. J. Hwang, An AR-based mobile learning system to improve students' learning achievements and motivations in natural science inquiry activities. Journal of Educational Technology and Society, vol. 17, no. 4, pp. 352–365, 2014.
[5.] M. Sirakaya and D. A. Sirakaya (2018). Trends in educational AR studies: a systematic review. Malaysian Online Journal of Educational Technology, vol. 6, no. 2, pp. 60–74.
[6.] M. Akçayır and G. Akçayır (2017). Advantages and challenges associated with AR for education: a systematic review of the literature. Educational Research Review, vol. 20, pp. 1–11.
[7.] Azuma, R. T. (1997). A survey of augmented reality. Presence, 6(4), 355-385.
[8.] Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995). Augmented reality: a class of displays on the reality-virtuality continuum. Proceedings of the SPIE Telemanipulator and Telepresence Technologies (Vol. 2351, pp. 282–292).
[9.] Tuli, N., & Mantri, A. (2020). Experience Fleming's rule in Electromagnetism Using Augmented Reality: Analyzing Impact on Students Learning. Procedia Computer Science, 172, 660-668.
[10.] Sharma, B., & Mantri, A. (2020). Assimilating Disruptive Technology: A New Approach of Learning Science in Engineering Education. Procedia Computer Science, 172, 915-921.
[11.] Bozzelli, G., Raia, A., Ricciardi, S., De Nino, M., Barile, N., Perrella, M., ... & Palombini, A. (2019). An integrated VR/AR framework for user-centric interactive experience of cultural heritage: The ArkaeVision project. Digital Applications in Archaeology and Cultural Heritage, 15, e00124.
[12.] Aebersold, M., Voepel-Lewis, T., Cherara, L., Weber, M., Khouri, C., Levine, R., & Tait, A. R. (2018). Interactive anatomy-augmented virtual simulation training. Clinical simulation in nursing, 15, 34-41.
[13.] Arango-López, J., Valdivieso, C. C. C., Collazos, C. A., Vela, F. L. G., & Moreira, F. (2019). CREANDO: Tool for creating pervasive games to increase the learning motivation in higher education students. Telematics and Informatics, 38, 62-73.
[14.] Frank, J. A., & Kapila, V. (2017). Mixed-reality learning environments: Integrating mobile interfaces with laboratory test-beds. Computers & Education, 110, 88-104.
[15.] Durham, M., Engel, B., Ferrill, T., Halford, J., Singh, T. P., & Gladwell, M. (2019). Digitally augmented learning in implant dentistry. Oral and Maxillofacial Surgery Clinics, 31(3), 387-398.
[16.] Sahin, D., & Yilmaz, R. M. (2020). The effect of Augmented Reality Technology on middle school students' achievements and attitudes towards science education. Computers & Education, 144, 103710.
[17.] López-Faican, L., & Jaen, J. (2020). Emofindar: Evaluation of a mobile multiplayer augmented reality game for primary school children. Computers & Education, 149, 103814.
[18.] Foad, A. F. (2017). Comparing the use of virtual and conventional light microscopy in practical sessions: Virtual reality in Tabuk University. Journal of Taibah University Medical Sciences, 12(2), 183-186.
[19.]
[20.] Vasilevski, N., & Birt, J. (2020). Analysing construction student experiences of mobile mixed reality enhanced learning in virtual and augmented reality environments. Research in Learning Technology, 28.
[21.] Garcia-Bonete, M. J., Jensen, M., & Katona, G. (2019). A practical guide to developing virtual and augmented reality exercises for teaching structural biology. Biochemistry and Molecular Biology Education, 47(1), 16-24.
[22.] Sweeney, S. K., Newbill, P., Ogle, T., & Terry, K. (2018). Using augmented reality and virtual environments in historic places to scaffold historical empathy. TechTrends, 62(1), 114-118.
[23.] Stotz, M., & Columba, L. (2018). Using Augmented Reality to Teach Subitizing with Preschool Students. Journal of Interactive Learning Research, 29(4), 545-577.
[24.] Moro, C., Štromberga, Z., Raikos, A., & Stirling, A. (2017). The effectiveness of virtual and augmented reality in health sciences and medical anatomy. Anatomical sciences education, 10(6), 549-559.
[25.] Cihak, D. F., Moore, E. J., Wright, R. E., McMahon, D. D., Gibbons, M. M., & Smith, C. (2016). Evaluating augmented reality to complete a chain task for elementary students with autism. Journal of Special Education Technology, 31(2), 99-108.
[26.] Baran, B., Yecan, E., Kaptan, B., & Paşayiğit, O. (2020). Using augmented reality to teach fifth grade students about electrical circuits. Education and Information Technologies, 25(2), 1371-1385.
[27.] Liou, W. K., Bhagat, K. K., & Chang, C. Y. (2016). Beyond the flipped classroom: A highly interactive cloud-classroom (HIC) embedded into basic materials science courses. Journal of Science Education and Technology, 25(3), 460-473.
[28.] Alalwan, N., Cheng, L., Al-Samarraie, H., Yousef, R., Alzahrani, A. I., & Sarsam, S. M. (2020). Challenges and Prospects of Virtual Reality and Augmented Reality Utilization among Primary School Teachers: A Developing Country Perspective. Studies in Educational Evaluation, 66, 100876.
[29.] Sáez-López, J. M. S. L., Sevillano-García, M. L. S. G., Pascual-Sevillano, M. Á. P. S., Sáez-López, J. M., Sevillano-García-García, M. L., & de los Ángeles Pascual-Sevillano, M. (2019). Application of the ubiquitous game with augmented reality in Primary Education. Comunicar. Media Education Research Journal, 27(2).
[30.] Taskiran, A. (2019). The effect of augmented reality games on English as foreign language motivation. E-Learning and Digital Media, 16(2), 122-135.
[31.] Buchner, J., & Zumbach, J. (2018). Promoting Intrinsic Motivation with a Mobile Augmented Reality Learning Environment. International Association for Development of the Information Society.
[32.] Vega Garzón, J. C., Magrini, M. L., & Galembeck, E. (2017). Using augmented reality to teach and learn biochemistry. Biochemistry and molecular biology education, 45(5), 417-420.
[33.] Liu, T.-Y., & Chu, Y.-L. (2010). Using ubiquitous games in an English listening and speaking course: Impact on learning outcomes and motivation. Computers & Education, 55(2), 630–643.
[34.] Chang, C.-W., Lee, J.-H., Wang, C.-Y., & Chen, G.-D. (2010). Improving the authentic learning experience by integrating robots into the mixed-reality environment. Computers & Education, 55(4), 1572–1578.
[35.] Di Serio, Á., Ibáñez, M. B., & Kloos, C. D. (2013). Impact of an augmented reality system on students' motivation for a visual art course. Computers & Education, 68, 586–596.