The Development and Evaluation of Multimedia Situational Examinations

Yan-Ping Huang*

Department of Computer Science and Information Engineering, Minghsin University of Science and Technology, Taiwan.

*Corresponding Author: sunny168@must.edu.tw

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ABSTRACT

Civil service examinations are important talents selection, but the traditionalpaper and pencil test has limits to do the selection. However, Objective Structured Clinical Examination (OSCE) involves huge manpower and cost. How to reduce the huge manpower and cost burden from OSCE? Is the situational examination a solution for reducing the huge manpower and cost burden from OSCE. How to design the situational examinations from OSCE examinations? This study is based on the qualitative research in medical situational tests and system simulation research study with virtual reality in civil service examinations. We transformed, classified and analyzed the data as the basis for developing multimedia situational examinations. In the system simulation research study, we discussed how to use science and technologyin the medical civil service examinations. The study aimed to make a prototype of application with situational examination services. The research made two significant contributions: firstly, it discussed the integration of imaging technology in civil serviceexaminations, and secondly, it developed a prototype for situational examinations.

Keywords: ShareCourse, Situational examination, Objective structured clinicalexamination, Virtual reality

1. Introduction

In the past, medical tests were administered by paper and pencil. A situational examination was more and more important to be administered online. Medical professions were different from other occupations, and medical and nursing educations were professionally developed in Taiwan. The development of nursing domain was crucial and should not be disregarded. At present, nursing education is employing multimedia instruction or computer-based learning [1]. Unlike the traditional learning, multimedia education, as an innovative educational approach, involves conveying concepts and educational knowledge to learners in a more accessible manner, more expansive and appealing, incorporating scenario

videos, text, audio, and images [2,3]. In recent years, the use of multimedia education in theclassroom has gathered great attention in Taiwan, and it was completely subverting the traditional model of learning by allowingstudents to access and use related learning devices according to BYOD policy (Bring Your Own Device) such as laptops, iPads and smart phones.

The research used the qualitative research; the situation, design method, and science technology in the medical test were developed by ShareCourse platform. ShareCourse platform is a web-based e-learning system. It combines virtual memory technology with real time technology in video learning. Our research provided one case study of situational medical civil service examination with virtual reality (VR) in the ShareCourse Platform.

The study was directed by the following research questions:

1. From the perspective of medical staff, the civil service examinations were digital, unable to respond to multiple intelligences; how to improve the traditional examinations?
2. What are the concerns and issues of using BYOD policy, augmented reality, virtual reality and multimedia contexts integrated into national examinations?
3. How to design integrative multimedia situational civil service examinations in medical education?

2. Literature Review

In recent years, research in VR/AR has expanded its scope to achieve a deeper understanding of multimedia learning. This chapter introduces the related literature. The literature review included four sections. 2.1 Medical education. 2.2 Text learning. 2.3 Multimedia learning. 2.4 Virtual reality learning. 2.5 Augmented reality learning.

2.1 Medical Education

The number of registered candidates was more than twenty thousand people for each year. Those who pass the National Examination of Registered Professional Nursesreceived the license to take care of people's health and promote public benefit. The quality of medical service had a significant influence on national health in a nation; both nursing education and national licensure examination were connected. Several researches had showed that the questions in the test need to be modified [4-6]. Currently, nursing education incorporates multimedia education or computer-based instructions. However, so far, the National Examination of Registered Professional Nurses had traditionally included only the written examination with multiple-choice questions. How to enhance nursing education and examination to raise the quality of medical service had become a global trend and was also of a great concern in Taiwan. To raise the quality of medical service, educators used new techniques and technologies to support nursing students' learning [2,7]. Multimedia applications such as situational learning and scenario-based learning (SBL) were being more heavily utilized for clinical courses in medical education [8,9]. The study was based on the qualitative research in medical situational examinations in order to raise the quality of medical

examinations.

2.2 Text learning

Delivering appropriate text segments comprised of multimedia instructions with an emotionally tailored format has the potential to steer learners' focus, heighten cognitive processing, and ultimately yield enhanced learning outcomes. Furthermore, texts with a considerable emotional resonance were thought to impact learners' emotional states. When examining the interrelationship between emotions and texts, it was crucial to differentiate between two distinct aspects: (1) Texts inherently harbor emotional potential, discernible through linguistic features that denote the presence of emotional elements within the text. (2) Through emotionalization, this innate capacity for evokingemotions can trigger emotional responses in the reader, thereby influencing alterations in their emotional state. Because emotionalization processes rely on the reader, the design of an emotionally charged text can solely impact the fluctuation in the emotional potential ofthe text. It is assumed that this variability helps facilitate emotionalization processes [10].

2.3 Multimedia learning

Mayer characterized multimedia learning as the acquisition of knowledge from an instructional message comprising textual, pictorial, and video information [11]. A three-step model of selecting, organizing, and integrating was posited to represent theestablished processes of multimedia learning [12]. Evidence supported the idea of a positive impact on learning through the implementation of a positively emotionally designed pictorial elements within multimedia instructional messages. These effects could be attributed to the attention-directing role of specifically redesigned relevant pictorial elements, potentially leadingto more efficient cognitive processing of the learning content [13]. The Cognitive- Affective Theory of Learning with Media (CATLM) integrates affective and cognitive dimensions of multimedia learning into a cohesive theoretical framework. Within the framework of cognitive load theory, which acknowledges the limitations of working memory, three key processes in multimedia learning are delineated. Firstly, affective and motivational factors are recognized to impact learning outcomes. Secondly, meta-cognitive and self-regulatory skills are identified as mediating learning by regulating both cognitive and affective processes. Thirdly, learner characteristics, such as prior knowledge, are acknowledged to influence the effectiveness of multimedia learning [14-16].

Recent research has indicated that multimedia materials can be crafted to evoke positive emotions [17]. An approach to eliciting positive emotions involves emotionaldesign, which entails imbuing the core elements of a lesson with human-like features to enhance their emotional appeal [18]. Stark extended the study of multimedia learningby incorporating eye movement analysis to explore the potential expansion of emotional design [19].

2.4 Virtual Reality Learning

In the 1960s, computer graphics pioneer Ivan Sutherland first proposed theconcept of virtual reality (VR), envisioning the creation of a synthetic environment through visualization with the aid of a head-mounted device. Boeing indeed played asignificant role in the development of augmented reality (AR) during the surge ofvirtual reality (VR) in the 1990s. The system they were developing aimed to overlayvirtual graphics onto a real environment, particularly to assist aircraft electricians intheir cable assembly tasks. This application of AR technology showcased its potential for enhancing productivity and efficiency in industrial settings, laying the groundwork for its further exploration and development in various industries beyond aviation [20].According to Burdea and Coiffet (2003), virtual reality was characterized as I3, representing "Immersion-Interaction-Imagination." [21]. The concept of virtual reality(VR) encompassed the utilization of 2D or 3D graphic systems along with diverseinterface devices to simulate immersion within an interactive virtual environment [22].To enable learners to engage with VR environments, special interfaces were required.

These interfaces were designed to input commands from the learner into the computerand provide feedback from the simulation to the learner.

VR technology had found successful application in educational contexts, forming the foundation of what was referred to as Virtual Reality Learning Environments(VRLEs) [23]. VRLEs facilitated the visualization of 2D or 3D data and offered an interactive environment that enhanced the sensation of immersion in a computer- generated virtual world. VR provided a platform to simulate realistic and safe environments for learners to engage in specific tasks. Additionally, it offered real-time simulation using three-dimensional computer graphics to replicate real-world scenarios.Medical training systems employing virtual realities [24, 25] or mixed reality [26] are becoming increasingly popular. Medical school students were mandated to undergoextensive training in surgery and acquire medical skills. The integration of computer vision technology was anticipated to enhance medical education by streamlining the learning process. The VR environment boasted a low-cost advantage; however, users did not experience full sensory immersion in the learning environment. Learners utilizing personal computer VR systems were less prone to motion sickness and fatigue compared to true immersive VR experiences [27].

2.5 Augmented reality learning

According to the 2011 Horizon Report, augmented reality (AR), with its capacityto superimpose data onto three-dimensional space, engendered fresh perspectives and experiences of the world [28]. By merging computer models of anatomical structures with tailored software, we could provide students with inventive ways to interact with anatomy, surpassing the limitations of cadaveric dissections or static images and diagrams [29]. Cheng and Tsai (2013) identified significant trends and potentialresearch avenues for AR-enhanced science learning. Their study involved a comprehensive review of journals indexed in the

Web of Knowledge and Scopus databases spanning from 2004 to 2011. They carefully selected 12 articles or studies that employed AR technology in science education for analysis. They highlighted various aspects including AR features, educational settings, participants, and the advantages in science learning. Ibáñez and Carlos conducted a comprehensive systematic review of the literature focusing on the application of augmented reality technology to enhance science, technology, engineering, and mathematics (STEM) education. Regarding reading speed in AR and VR environments, text was utilized in both VR and AR applications. The present study investigated reading performance in both VR and AR contexts. Users should be cognizant of this distinction and allocate approximately 10% more time when engaging with VR and AR applications that include textual components [30].

Augmented reality systems offered the advantage of embedding and/or superimposing information onto reality, allowing for a presentation of medical knowledge that closely resembled real-life scenarios and providing opportunities for innovative and interactive learning contexts. Users could spatially relate virtual objects to reality, enhancing their understanding. However, the development of AR systems posed challenges. Achieving accurate calibration, implementing advanced visualization techniques, and designing user interfaces that seamlessly integrate real and virtual objects were demanding tasks [31].

Text learning is reader-dependent and it offers just text information. Multimedia learning could offer instructional message containing textual and pictorialinformation. However, the multimedia learning was in a sequenced order. The processes could link the organized information to prior knowledge. The VR environment had a low-cost advantage and it has well feedback with user. Augmented reality-based simulation, in conjunction with feedback would allow modeling more realistic interaction without the need of expensive, yet still deficient models. The time in reading performance on VR and AR applications might explore more over 10%. 2.5Virtual reality in medical examination Virtual reality and augmented reality were increasingly being utilized in medical domains, including medical education and training, surgical simulation, neurological rehabilitation, psychotherapy, and telemedicine. The design of virtual reality applications typically followed a content-driven approach, prioritizing the content andcontext of the application. Surgical simulation used virtual reality technology, training through surgery combined with 3D virtual models [32, 33]. Using Augmented reality technology in 3D model projection was evident in human organ medical education [34]. Viewing FMRI's 3D images with virtual glasses could improve clinical training and surgical skills [35]. Research findings indicated that virtual reality and augmented reality had the potential to alleviate the challenges commonly associated with traditional medical care, decrease instances of medical malpractice resulting from inexperienced procedures, and lower the expenses associated with medical education and training.

3. Qualitative research

3.1 Research Design

A semi-structured face-to-face interview method was utilized. Taking into accountthe busy schedules of participants, interviews were arranged at times convenient for each individual participant. They were conducted over a three-month period from Aprilto June 2023, with each interview lasting approximately two hours on average. In-depth data had been collected and transcribed for categorization and analysis based on the questions.

3.2 Participants

The participants for this research were selected from the recommended lists by Ministry of Examination, representative of foundations for doctors, nursing educational system, professors, examiners, and registered professional nurses. They had the willingness to participate and came from different cities across Taiwan, representing north, central and south regions. Table 1 shows the basic information for the participants. Participants' privacy and confidentiality were preserved and the information had been coded. The interviewees were selected by the Examination Institute and the medical academic community.

Table 1. Interview Committee Code

NO	Code ID	Sex	Personal status
1	DMER4000CWW	M	Doctor
2	NFER4000F0L	F	Nursing staff
3	DMGM1000PMY	M	Doctor
4	NFP01000BSG	F	Nursing staff
5	DMA08000KML	M	Doctor
6	NFOG8000FHC	F	Nursing staff
7	NFP08000XXZ	F	Nursing staff
8	DMFM1000SLT	M	Doctor
9	NFC01000HHT	F	Nursing staff
10	NFP04000WJY	F	Nursing staff
11	TFC01000HYT	F	Professor
12	TFC01000JYT	F	Professor

3.3 Data Collection Procedure

This study used qualitative research method. Research topics were derived during in-depth interviews. The study period was from April 20, 2023 to July 30, 2023. We visited12 medical staffs and the total times were 9 times. With the help of multi-disciplinary experts, we could design and integrate multimedia situational examination methods by using

suggestions from the interview committee members.

3.4 Data Analysis and Results

We transformed, classified and analyzed the data as the basis of developing the multimedia situational examinations. Table 2 shows the research object statistics, therewere five doctors, five nurses and two evaluation experts. Table 3 shows the gender distribution statistics. All the participants were 4 males and 8 females, and ranging in age from 23 to 96 years. Table 4 shows distribution of medical services.

Table 2. Research Object Statistics

	Doctor	Nursing staff	Evaluation expert
Total number	5	5	2

Table 3. Gender distribution statistics

Gender distribution	Male	Female
Total number	4	8

Table 4. Distribution of medical services

medical services	
Emergency Department	2
Internal Medicine	2
Pediatrics	1
Anatomy	1
Gynecology	1
Psychiatry	2
Family	1
Evaluation Expert	2

4. The Emerging Technologies in Medical Situational Examinations: Concerns And Issues

4.1 The Civil Service Examinations Are Digital to Improve the Traditional Examinations

The multimedia situations in civil service examination of comprehensive questions or medical ethics issues, increase the variability of examination and theability of the site to respond. It also improves professional ability (DMGM1000PMY; NF P01000BSG; DMA08000 KML; NFOG8000FHC; DMFM1000SLT; NFC01000HHT; NFP04000WJY; NFC010 00HYT; NFC01000JYT). The multimedia situational examinations require

cooperation between the medical experts (professionalfield), the test evaluation experts (test field) and the AI project team (in the science and technology field) to jointly establish the situational proposition assessment system platform to build the entire structure and design (DMGM1000PMY; NFP04000WJY; NFC01000HYT; NFC01000JYT).

The direction suggested to contextualize these situational examinations can be used in the class in each and every school (NFOG8000FHC). After each school gradually adapts to themultimedia situational examinations, it takes up 1/5 of overall test score, and the rest of questions can still be answered by paper and pencil (NFP01000BSG). After 10 years of promotion, the use of artificial intelligence to introduce multimedia situationalpropositions and questions in the field of national examination and medical care, clinical reasoning, problem-solving ability, priority setting, is expected to reach 90% (DMGM1000PMY). The 12 people interviewed agreed that emerging technologiessuch as multimedia, virtual reality, augmented reality, BYOD policy, improve the civilservice examinations. At present, the teaching scene in the medical schools had begun to use virtual realityor augmented reality equipment. They combined the traditional teaching course with these emerging technologies and problem-based learning (PBL) in innovative teaching.They taught students human body structure, clinical simulation training, and integration into science and technology teaching. The emerging technologies attractedstudents' attention. The situational propositions were flexible. The students could see the video. According to the diagnosis, the student could use the given status and response. The emerging technologies had good benefits (DMER4000CWW; NFER4000F0L; DMGM1000PMY; NFP01000BSG; DM A08000KML; NFOG8000FHC; NFP08000XXZ; DMFM1000SLT; NFC01000HHT).

In the multimedia situational teaching, standardization of propositional questions(the patient was fake) used to test the clinical skills of medical students.There were two key points of standardization: (1) Students tested in clinical skills on standardized patients (through passive interaction) cannot chat with the candidates like ordinary patients; (2) If the candidates asked questions outside the script,the standardized patients would not be able to play the script (DMGM1000PMY). In addition, the students would be afraid of BYOD equipment painting. (DMER4000CWW; NFP01000BSG; DMA08000KML; NFP08000XXZ; NFC01000HHT).

In analyzing the data, two categories emerged: (a) The use of multimedia, virtual reality or augmented reality technology in medical situational scenarios for examining clinicalskills. (b) The consideration of BYOD and AI in the National Registered Professional Nurse Licensing Examination. Despite BYOD's advantage, it had some limitations. More than half of examinee on medical civil service examinations were concerned that their environment could not afford high performance equipment such as smartphone, iPad and notebook. Using AI and BYOD in the examination had challenged nursing college students. The study discussed how to use science and emerging technology in the civil service examinations. The way to go was to improve the national examination mechanism in the Ministry of Examination.

This study set out to understand the use of BYOD and AI in the National Registered Professional Nurse Licensing Examination as a means to present a critical overview ofexisting concepts and technologies in the field of nursing education based on Problem-Based Learning (PBL), to explore potential integration of emerging technologies in improving civil service examinations in Taiwan.

4.2 Case study: The situational examination of medical wound suture in Share Course

The ShareCourse platform (www.sharecourse.net) had many functions: search course, course announcement, course progress, course forum, course film, quiz,virtual room etc. It could offer a complete learning experience for students. Students could read the course information or test on website or mobile.

Case: A hand-injured patient came in the emergency room with a 3-cm wound. The doctor had completed the diagnosis and decided it needed to be sutured immediately. Your task was to assist with wound management and preparation. Students scanned the QR code and entered ShareCourse examination platform; the test time was 8 minutes. There were total of 10 questions, each question was a multiple-choice question.

Figure 1 shows that the student can scan the QR code to enter the ShareCourse examination platform. Figure 2 shows that students use the ShareCourse platform for multimedia situational examinations on website. Figure 3a shows that Students use the ShareCourse platform for multimedia situational examinations on mobile. Figure 3b shows that students can read the course information, such as scores. Figure 3c shows the situational examination in medical wound suture in ShareCourse.

Figure 1. Scanned the QR code to enter the ShareCourse examination platform

Figure 2. Students used the ShareCourse platform for multimedia situationalexaminations on website.

5. Conclusion and Future Research

Civil service examinations have traditionally been a critical method for talent selection. However, the conventional paper-and-pencil format has its limitations in this regard. This research employed a qualitative approach to explore the use of science andtechnology in civil service examinations. The study aimed to address how advancements in technology could enhance these examinations. Findings revealed thatsituational examinations, particularly for roles such as doctors and nurses, couldeffectively overcome the limitations of traditional paper-and-pencil tests. Implementing a"bring your own device" policy (BYOD) could serve as a scoring system, reducing the burden on assessors and ensuring fairness in the evaluation process.

This study on the design of situational examinations explored the use of virtual reality within ShareCourse. The aim of this simulation research was to immerse examinees in realistic examination scenarios. The outcome aimed to enhance the national examination process within the Ministry of Examination. The research focusedon creating a prototype application to deliver situational examination services. ShareCourse, an online e-learning platform, was utilized for facilitating these situational examinations. The future research will combine eye tracking with questionnaire studies to assess the impact of situational examinations.

Reference

[1] Button, D., Harrington, A. and Belan, I. E-learning & information communication technology (ICT) in nursing education: A review of the literature. Nurse Education Today, 2014, 34(10), 1311-1323. doi:10.1016/j.nedt.2013.05.002.

[2] Demircelik, M. B., Cakmak, M., Nazli, Y., Şentepe, E., Yigit, D., Keklik, M. and Eryonucu, B. Effects of multimedia nursing education on disease-related depression and anxiety in patients staying in a coronary intensive care unit. Applied Nursing Research, 2015, 29, 5-8. doi:10.1016/j.apnr.2015.03.014

[3] Aghvamy, M., Mohammadzadeh, S., Gallalmanesh, M. and Zare, R. Assessment the education compariment to two ways: Group education and computer education on quality of life in the children 8-12 years suffering from asthma in the Valiasr hospital of Zanjan. Zanjan University of Medical SciencesJournal, 2010, 19(74), 78-85.

[4] Lee, S., Chang, T., Yen, W. J. and Wang, Y.S. Study on current situation, difficulties, and trends of RNteaching, testing, and employing from global competition perspectives. National Elite. 2010, 6(4), 29-45.

[5] Lee, S. and Chang, T. A Taiwan nursing perspective on current imbalances in educating, licensing and hiring new nurses. The Journal of Nursing, 2012, 59(5), 16-23. doi:10.6224/JN.59.5.16.

[6] Yu, Y.M., Dai Y.T. and Yeh, M.C. Perspectives on Nursing Education, Licensing Examinations and Professional Core Competence in Taiwan in the Context of Globalization. The Journal of Nursing, 2010, 57(5), 5-11.

doi:10.6224/JN.59.5.16.

[7] Moffett, J. and Mill, A.C. Evaluation of the flipped classroom approach in a veterinary professional skills course. Advances in Medical Education and Practice. 2014, 5, 415-425. doi:10.2147/AMEP. S70160.

[8] Cant, R., McKenna, L. and Cooper, S. Assessing preregistration nursing students' clinical competence: A systematic review of objective measures. International Journal of Nursing Practice. 2013, 19(2), 163-176.

[9] Fisher, D. and King, L. An integrative literature review on preparing nursing students through simulation to recognize and respond to the deteriorating patient. Journal of Advanced Nursing. 2013, 69(11), 2375-2388. doi:10.1111/jan.12174.

[10] Monika, S.F. Sprache und Emotion [Language and emotion]. Tübingen: Francke. Seufert, T. Supporting coherence formation in learning from multiple representations. Learning and Instruction. 2013, 13, 227-237.

[11] Albeedan, M. Kolivand, H. Hammady, R. and Saba, T. Seamless Crime Scene Reconstruction in Mixed Reality for Investigation Training: A Design and Evaluation Study, in IEEE Transactions on Learning Technologies, 17, 856-873, 2024, doi: 10.1109/TLT.2023.3337107.

[12] Mayer, R.E. Learning strategies for making sense out of expository text: The SOI model for guidingthree cognitive processes in knowledge construction. Educational Psychology Review. 1996, 8(4), 357-371.

[13] Park, B., Knörzer, L., Plass, J. L. and Brünken, R. Emotional design and positive emotions in multimedia learning: An eyetracking study on the use of anthropomorphisms. Computers & Education, 2015, 86, 30-42.

[14] Moreno, R. Instructional technology: Promise and pitfalls. In L. Pytlik Zillig, M. Bodvarsson, & R.Bruning (Eds.). Technology-based education: Bringing researchers and practitioners together. 2005, 1-19. Greenwich, CT: Information Age Publishing.

[15] Moreno, R. Does the modality principle hold for different media? A test of the method-affects- learning hypothesis. Journal of Computer Assisted Learning. 2006, 22, 149-158.

[16] Moreno, R. and Mayer, R. Interactive multimodal learning environments. Educational Psychology Review. 2007, 19(3), 309-326.

[17] Plass, L., Heidig, S., Hayward, E.O. Homer, B.D. and Um, U. Emotional design in multimedia learning: Effects of shape and color on affect and learning, Learning and Instruction. 2014, 29, 128-140.

[18] Clark, R.C. and Mayer, R.E. e-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning. John Wiley & Sons, Hoboken, USA, 2016.

[19] Stark, L., Brünken, R. and Park, B. Emotional text design in multimedia learning: A mixed-methodsstudy using eye tracking, Computers & Education. 2018, 120, 185-196.

[20] Caudell, T.P. and Mizell, D.W. Augmented reality: an application of heads-up display technology to manual manufacturing processes. The Proceedings of Hawaii international conference on system sciences. 1992, 659-669.

[21] Laine, T.H. and Lee, W. Collaborative Virtual Reality in Higher Education: Students' Perceptionson Presence, Challenges, Affordances, and Potential, in IEEE Transactions on Learning Technologies, 17, 280-293, 2024, doi: 10.1109/TLT.2023.3319628.

[22] Pan, Z., Cheok, A. D., Yang, H., Zhu, J. and Shi, J. Virtual reality and mixed reality for virtual learning environments. Computers & Graphics. 2006, 30, 20-28.

[23] Monahan, T., McArdle, G. and Bertolotto, M. Virtual reality for collaborative e-learning. Computers& Education.

2008, 50, 1339-1353.

[24] Miyake, Y. Development of Laparoscopic Surgery Training System Using VR Technology. The Conference of Machine Vision Applications. 2007, 556-562.

[25] Feuerstein, M. Mussack, T. Heining, S. M. and Navab, N. Registration free laparoscope augmentationfor intra-operative liver resection planning. Proc. SPIE Medical Imaging 2007.

[26] Birkfellner, W., Figl, M., Huber, K., Watzinger, F., Wanschitz, F., Hummel, J., Hanel, R., Greimel,W., Ewers, P. R. and Bergmann, H. A head-mounted operating binocular for augmented reality visualization in medicine - design and initial evaluation. IEEE Transactions on Medical Imaging. 2002, 21(8), 991-997.

[27] Samuel, S., C. Elvezio, S. Khan, L.Z. and Bitzer, L. Moss-Salentijn and S. Feiner, Visuo-Haptic VR andAR Guidance for Dental Nerve Block Education, in IEEE Transactions on Visualization and Computer Graphics, 30(5), 2839-2848, May 2024, doi: 10.1109/TVCG.2024.3372125.

[28] Cheng, K.H. and Tsai, C.C. Affordances of Augmented Reality in Science Learning: Suggestions for Future Research. Journal of Science Education and Technology. 2013, 22, 449-462.

[29] Minhua, M., Bale, K. and Rea, P. Constructionist Learning in Anatomy Education What Anatomy Students Can Learn through Serious Games Development. M. Ma et al. (Eds.): SGDA 2012, LNCS 7528, 2012, 43-58.

[30] Rau, P. L., Zheng, J., Guo, Z. and Li, J. Speed reading on virtual reality and augmented reality. Computers & Education. 2018,125, 240-245.

[31] Juan, C., Beatrice, F. and Cano, J. An augmented reality system for learning the interior of the humanbody. In Eighth IEEE International Conference on Advanced Learning Technologies. 2008, 186-188.

[32] Basdogan, C., Ho, C.H. and Srinivasan, M.A. Virtual environments for medical training: Graphicaland haptic simulation of laparoscopic common bile duct exploration. IEEE/ASME Transactions on Mechatronics. 2001, 6(3), 269-285.

[33] Gallagher, A.G. and Cates, C.U. Virtual reality training for the operating room and cardiac catheterization laboratory. The Lancet. 2004, 364(9444), 1538-1540.

[34] Kamphuis, C., Barsom, E., Schijven, M. and Christoph, N. Augmented reality in medical education? Perspectives on medical education. 2014, 3(4), 300-311.

[35] Izard, S.G. and Méndez, J.A.J. (2016). Virtual reality medical training system. In ACM Proceedingsof the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality. 2016, 479-485.