Developing cognitive processes as a major goal in designing e-health information provider VR environment in information science education

Gyöngyi Bujdosó[1], Kata Boros[2]
Faculty of Informatics
University of Debrecen
Debrecen, Hungary
[1]bujdoso.gyongyi@inf.unideb.hu
[2]boroskata84@gmail.com

Cornelia Mihaela Novac[3], Ovidiu Constantin Novac[4]
Faculty of Electrical Engineering and Information Technology
University of Oradea
Oradea, Romania
[3]mnovac@uoradea.ro
[4]ovidiuconstantinnovac@gmail.com

Abstract—**Information science has played an important role in computer science education in the last decades. The design of storing, retrieving and interacting with information is an obligatory part in development of numerous online services in our era. Therefore, many parts of information science are elementary components in the majors' curricula in computer science education. In this paper, we focus on a course on Information Architecture where students were introduced to the basics of information science. During the course, MaxWhere – an online virtual reality collaborative service – was used as a framework. In our research, our main goal was to develop the students' cognitive processes. The students' main task was to design and develop e-health services in virtual reality (VR) environment for impressing and persuading their future target audience to live a more environmentally conscious life or to live healthier. In this paper, we present some results of this experimental research: Students were motivated to create and design an inclusive project together that needed more work and knowledge from them than it had been planned. They were motivated to collaborate with their groupmates and a self-driven collaborative workflow was developed. They had to learn about the MaxWhere 3D VR system, and at the same time, they had to start to do research on their own projects. After a while, they found gaps in their designs that they wanted to fill in. As a consequence, the students had to deal with some theory and practice of marketing, e.g., they had to deal and work with buyer personas, with some other marketing aspects, and – of course – with some important parts of information science. They had to imagine their future customers and to develop VR environments for them that could have an impact on the users' behavior and lives. The design and development process resulted in and showed development in the students' cognitive processes.**

Keywords—developing cognitive processes; MaxWhere; virtual reality; VR; exploratory learning; teaching information science; e-health, higher education, cognitive infocommunication

I. INTRODUCTION

Infocommunication in modern information societies has become one of the most important aims and tools for both sides: for those who have data and provide information as well as for those who need and try to find information as part of their work or of their daily activities. This change has an impact on many areas from the economy [1] through education [2] to the daily activities of the members of modern societies [3] even if the meaning of this expression keeps changing and has to be redefined, time and again based on the development of communication [4].

The traditional methods of infocommunication has needed to be extended in our modern era: cognitive sciences had to be integrated [5] [6] to raise the communication and distribution of information to a higher level.

In this paper, we focus on those cognitive infocommunication methods that can be used in 3D virtual reality environments for improving the cognitive processes during designing a digital environment for education and for non-traditional information transfer methods.

The deep impact of information displayed in 3D environment has been demonstrated in some researches in business, e.g., in marketing [7] [8] [9] [10]. 3D environment and virtual reality started to be used also in education [11] [12] [13] [14] [15], because of their special influence on the educational process [16] [17] [18]. Research results show that the VR environments can ameliorate the effectiveness of learning [19] [20], and provide possibilities to improve the learners' various skills (e.g., business skills [21] [22]) or to develop rehabilitation of environment [23] [24].

Libraries in the 21st century have to deal with the new technologies, even if these technologies belong to the disruptive category, such as augmented or virtual reality. These technologies can be used as frameworks for their services, i.e. as virtual environments for digital libraries [25], or can yield some online services that make available the most valuable treasures of a library to the users [26]. Libraries were always pioneers in this field: they introduced modern technologies to the working processes of their traditional and historical institutions. In the information age, they started to digitize books and other document types as soon as it was possible to make a large amount of online, digitalized content [27] accessible. As a result of their efforts on digitization, we have a number of huge digital collections, think of, e.g., the Project Gutenberg (established in

1971) that provides thousands of free e-books. They designed and applied standards for making data exchange and infocommunication possible and easy [28] [29]. They started to embed modern technologies in their services almost immediately when they became available.

These are the main reasons why we have to teach and apply the newest technologies in the education of teachers and librarians of the modern era. They have to be prepared not only to use the new technologies but to find new ways for using them and adjust the communication to the new generations and try to find ways to improve their communication methods in their work.

II. Virtual Reality

Before presenting our research we have to talk about the information technology that we used in this research.

Virtual Reality (VR) has a number of benefits concerning infocommunication in a digital society. It involves many of those technologies, methods, and activities that people like to use or do when they are working or spending their spare time such as computers, mobile devices, the Internet, as well as distributing, sharing information, communicating, storytelling and so on [30]. A very important benefit of VR that any type of media that people like can be embedded in these environments. VR can integrate technologies from many fields starting from computer graphics trough human-computer interaction and user experience design, to artificial intelligence [31], parts of multimedia and others. When the possibility of immersion is added to such a space, its usability is raised to a higher level. So these 3-dimensional, customizable immersive MaxWhere (see later) spaces that can be used as a personalized bookshelf [32], or as a medieval church [33] provides natural environment for their users where they can work as in their natural offices or in other virtual spaces they prefer to use.

A. MaxWhere – A 3D virtual reality platform

MaxWhere [34] is a 3D environment that acts as a free VR platform, a VR framework that is programmable by using JavaScript. It gives possibilities to build 3D VR spaces for its users. As a result, MaxWhere provides 3D VR spaces for work and offers more and more free, predesigned and developed 3D spaces for use.

MaxWhere has many default spaces that people can use and where they can design and create their own comfortable working environment. The system provides an easy to use interface for applying designed and equipped environment.

This collaborative and immersive virtual reality system provides possibilities to develop applications and to develop people's own spaces, as well. After drawing a given space, it can be imported into MaxWhere and can be used as an immersive virtual reality environment for collaboration.

B. VR at our institutions

In our universities, we started to use the VR technology and environment some years ago for improving teaching and learning processes. We started to use VR by using the VirCA Virtual Collaborative Arena [35] in some researches some years ago. Later we used the MaxWhere – a new platform from the developers of the VirCA.

We started to use VR as a framework for developments (VirCA in [29], [36]). Later we introduced it into our teaching processes ([37]). It turned out that the VR environments have many benefits in the teaching processes: the students liked to learn and use the new technology, they were motivated to use it. So we continued to use MaxWhere in education and we examined the results of the VR usage.

III. E-health in VR: Designing virtual environment as a course project

A. About the research

The main aim of our research was to develop those cognitive skills of the students that they need to design, manage and perform projects. This research focused on a special part of cognitive infocommunication where the students have to design environments that will have a profound impact on the behavior of their future users who will use these e-health services.

The students who participated in this research learned library and information science on bachelor level. Being librarians in a digital age needs many skills in the fields of infocommunication. During their studies, we have to pay attention to the development of these skills. That was the reason to introduce VR in library education. During an Information Architecture course, students had to design, manage and perform a project by using MaxWhere. They had to design a space for infocommunication applied between the library and its users. It should catch the attention of their future users and persuade them to live healthier and/or to behave a more environmentally conscious life. They could use MaxWhere's predesigned 3D spaces for preparing the environment for infocommunication.

B. Methods

Every student had to choose a topic for his/her project that would have significant importance in the field of health promotion. Information systems with online services had to be developed for an imaginary library ('Library') in 2025. The Library intends to expand its online services.

1) Role: The students were librarians in this Library. Every librarian had to develop an infocommunication method and channel between the Library and its clients for making the Library's service palette wider.

2) Students' main goals: Everyone had to design and prepare an information system in a digital 3D environment that can be engaging and useful for their users and can persuade them to use this environment. To achieve these goals, they had to collect data and information about the chosen project topics. They had to collect the most relevant and reliable pieces of information and communication methods about it. They had to use those modern media that can be integrated into the VR space. They had to find those communication methods that the library can apply and arouse client interest and can be useful for them. They had to create a modern library that can provide a high standard of service. It was suggested to communicate with their groupmates about the topics and collaborate in the project work.

3) VR: Every student had to choose a free 3D VR space in the MaxWhere that fits the project topic. They had to design the content and adjust it to the given VR space, and they had to organize and place the collected pieces of information and insert the online services they chose into the VR space.

4) Evaluation: At the end of the semester, students had to demonstrate the designed and prepared VR environment in a "promotional meeting" where the bosses of the Library made a decision about the integration of the new services into the Library's service palette. The bosses were the other students of both groups and the teacher. They evaluated the presented services together, by consulting about them, and made a decision based on a predefined list of evaluation criteria.

IV.   RESULTS

As a result of this course project work, students presented well-designed and well-organized environments that were filled with relevant, reliable and useful pieces of information, and a concept was drawn at the end of the semester that was a result of the students' collaboration.

A. A new concept was created and specified

One of the main positive results was that the students worked together, they collaborated on defining the topics and created a common concept: They designed an e-Health Promotion (eHP) project for the Library as a group of new services on health and environmental protection for its clients by providing relevant and reliable information and services. (E-health [38] and sustainable development strategies have more and more relevance in the modern societies.) Every student specified his/her project as a sub-project within this eHP project and they aligned the services to each other's sub-projects to have a compact service provider environment set. As a result of this collaboration, they developed a new group of services in a modern Library that could connect the library to the Institute of Sport Science at the university. It was an extra benefit of this project work that the students could think about the future that is important for the employees of this modern era.

B. Self-directed collaboration was included

We have to mention self-developed collaboration as a positive result of the students' work activities.

In our individualized societies, encouragement for cooperation has of great importance mainly at universities. For the students' future work, they have to learn the ways of collaborations that will be an important skill during work. Partly due to the current structure of the education system, collaborative works do not have enough possibilities in higher education compared with the arising needs from the industrial area. The result usually is that students do not consider collaboration. The educators have to inspire them to work together.

In the description of this project, collaboration was explicitly suggested only for choosing a topic (to ensure the diversity of topics). For the next steps, we did not tell anything about cooperation or collaboration because we wanted to see if the students started to collaborate during their project work to improve the quality of the final result.

The students not only started to collaborate in defining the topics, but they did more, they created a concept that could be a real project of the Library. They aligned their topics to this concept, they found a common and a separate set of problems that they could work out and design for the inclusive project. The collaboration continued during the whole semester, they coordinated their own work in virtue of their specified main goal.

C. Thinking of future users

When students started to collect the sources and services, they realized that they do not know anything about the needs of their future users. They saw that they cannot fulfill the needs of all of their users, so they should somehow restrict the set of needs that they would like to meet.

As a consequence, the students had to deal with the theory and practice of marketing, e.g. they had to deal with buyer personas. They prepared buyer personas for their services. For every service, two or four buyer personas were created that helped the students in designing the functionality of the services. Based on these services they could choose the language of the communication, and could control the offered services in the VR environment.

D. Content: Selection and composition were creative

The students collected relevant and reliable pieces of information and online services on their sub-project topics. They tried to find connections between the sub-projects and designed the sub-projects as parts of the eHP project for making a compact group of services that caters to many areas of the eHP – that the Library's clients can be interested in.

Many types of media were applied in these environments from simple texts and pictures through different kinds of infographics, videos, animations, interactive maps, voting systems, social media, and other services.

The topics that the students chose, formed a creative set of services. It contained many areas from the healthy life through the misconceptions (of which we can find more and more on the Internet), and the explanations of the misconceptions to those online services that could provide solutions or help concerning the problems that can arise in the specified area. In this paper we talk about only some of these environments:

Health – Bear in Mind: This VR environment was designed for those people who have problems with the most frequent addictions. This environment provides a set of information about addictions and websites where addicted people can find help.

Water in our Environment: This environment is about the role and protection of water in our world. It provides information about the importance of drinking water. This topic is relevant in our climate that is changing and become much warmer than before. This environment draws the attention of the audience for example to those mobile applications that can help to drink enough every day. It speaks about some misconceptions related

to the water and suggests places and movements where the users can join to protect our local and global environment.

Live Healthily: This environment consists of some important and relevant areas in the field of sport psychology, living in a healthy way, and about some misconceptions concerning foods, bodies, eating habits, and so on. These misconceptions can cause serious problems for people who do not know enough about the system functions of the human body or about chemical processes.

Reliability was an important criterion, so the reliability of the services and the sources were checked and presented by the students.

E. Use of Web 2, 3 and 4 services are designed

In the previous section, we described the different and specific parts of the developed environments. Here we present some of those modern services that were commonly used but, of course, the topics, the final goals and the functions of these services were different depending on the environments' topics.

Because our Library will work in the future, the students could plan services concerning the future, though not every service is available now. Some of the services cannot be included in a functioning way because they are currently not free of charge, nevertheless the students can count with them because the Library might be able to pay for them in the future. We list some of these services

- Communication channels among those users who are interested in the same topic;

- Possibilities of collaborations among the users;

- Information sharing possibilities for users. The content is checked by a moderator;

- Event list where the users can join this environment – depending on the current location of the given user;

- ChatBots that can answer the commonly asked questions;

- Professionals who are always online (i.e., somebody is online always) and can talk with those who need it. It can be very important in some cases, for example, for those who have addiction problems.

F. The VR environments

Here we present the previously mentioned environments in order to demonstrate the developed VR environments. (See also in [39].)

We present the VR spaces and the way how the students filled these spaces with pieces of information and services. They had to organize and group the sources to be presented into a natural order that the users can use without any problem, and they had to include and join those pieces of information that belong to each other, and this arrangement can motivate users to read or watch them (see e.g. Fig. 1, Fig. 2, Fig. 3, and Fig. 4).
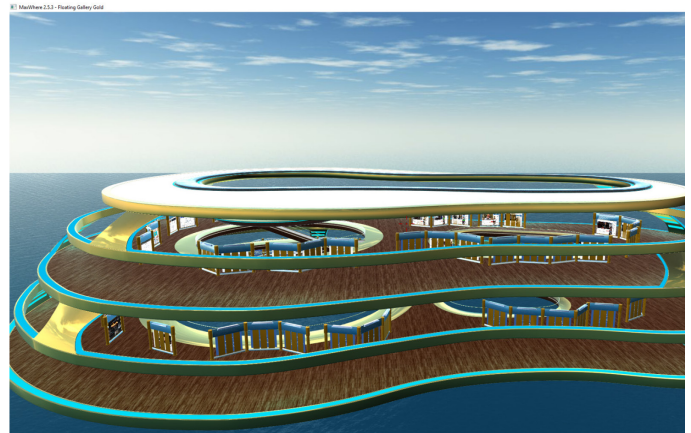

Fig. 1. The complex *Live Healthily* service on four levels with many displayed pieces of information, with collaborative, inteactive, shared and other online services offered

Fig. 2. The atrium of the *Live Healthily* VR environment. Info panels about the misconceptions ('Tévhitek' in Hungarian) can be seen from many points of the VR space

Fig. 3. A view of the environment: *Health – Bear in Mind.* After entering this space (this view) the start point (the big eye) can be seen on the first floor and the help services (written on the big blue arrow) on the second floor. So the user does not have to go through the VR space if immediate help is needed

Fig. 4. The VR environment of *Water in our Environment,* that has an open clear structure demonstrating its topic

V. Conclusions

On top of their individual projects, the students created one big e-Health Promotion project and defined their projects as subprojects of the Library's e-Health Promotion project. They created a concept that was a guideline for designing their own subprojects that formed a compact set of services. They specified the connections between the subprojects and integrate connections into their own VR spaces. They developed a self-directed collaboration that resulted in a higher-level of development. Students were creative concerning the content, the placements of the contents as well as the integrated or planned services. They learned the usage of the MaxWhere VR space and tried to take advantage of all of its opportunities. They designed and developed services in VR environments that are based on their preliminary concepts and made connections between these services for creating a compact system for a library of the future.

The VR system had an important role in this project because it motivated the students for developing new concepts and designing one bigger system as a framework of their own projects. It had a motivating effect on the field of collaboration, too. Students tried to apply all of the possibilities of these VR spaces, so they worked together to achieve their goals. In this new, virtual environment the students worked in a well-organized, self-directed way with a high level of collaboration. That was a nice presentation of project work in the 21st century.

Acknowledgment

References

[1] P. Vorobiyenko, "The role of infocommunications in the world-wide human society development," In: Proc. of International Conference on Modern Problem of Radio Engineering, Telecommunications and Computer Science. IEEE, 2012. pp. 25-26.

[2] N.Z. Safiullin,. I.R. Gafurov, L.N. Safiullin, J.L. Odintsova, "Education system of the world: Modern trends," Mediterranean Journal of Social Sciences, vol. 5, no. 18, pp. 91-94, 2014.

[3] S. Burch, "The Information Society–the Knowledge Society," Word Matters, May, 2006.

[4] G. Sallai, "Defining infocommunications and related terms," Acta Polytechnica Hungarica, vol. 9, no. 6, 5-15, 2012.

[5] P. Baranyi, Á. Csapó, "Definition and synergies of cognitive infocommunications." Acta Polytechnica Hungarica, vol. 9. no. 1, 67-83, 2012.

[6] R. Klempous, J. Nikodem, P. Baranyi, (Eds.), Cognitive Infocommunications, Theory and Applications," Heidelberg, Springer, 2019.

[7] W. Wossen Kessaye, "Virtual reality as source of advertising," Journal of Website Promotion, vol. 2, no. 3-4, pp. 103-124, 2007.

[8] B. Berki, "2D Advertising in 3D virtual spaces," Acta Polytechnica Hungarica, vol. 15, no. 3, pp. 175-190, 2018.

[9] K. Kapusy, E. Lógó, "Values derived from virtual reality shopping experience among generation Z," In: IEEE – 8th International Conference on Cognitive InfoCommunications : CogInfoCom, Piscataway (NJ), IEEE Computer Society, pp. 237-242, 2017.

[10] H. Van Kerrebroeck, M. Brengman, K. Willems, "When brands come to life: experimental research on the vividness effect of Virtual Reality in transformational marketing communications," Virtual Reality, vol. 21, pp. 177-191, 2017.

[11] S. Jang, J. M. Vitale, R. W. Jyung, J. B. Black, "Direct manipulation is better than passive viewing for learning anatomy in a three-dimensional virtual reality environment," Computers & Education, pp. 150-165, 2017.

[12] V. Kövecses-Gősi, "Cooperative learning in VR environment," Acta Polytechnica Hungarica, vol. 15, no. 3, pp. 205-224, 2018.

[13] B. Lampert, A. Pongracz, J. Sipos, A. Vehrer, I. Horvath, "MaxWhere VR-learning improves effectiveness over clasiccal tools of e-learning," Acta Polytechnica Hungarica, vol. 15, no. 3, pp. 125-147, 2018.

[14] A. D. Kovacs, Z. Kvasznicza, "Use of 3D VR environment for educational administration efficiency purposes," In: Baranyi, P., (Ed.), IEEE – 9th International Conference on Cognitive Infocommunications: CoginfoCom 2018 Proceedings, IEEE Computational Intelligence Society, pp. 361-366, 2018.

[15] I. Horvath, A. Sudar, "Factors contributing to the enhanced performance of the MaxWhere 3D VR platform in the distribution of digital information," Acta Polytechnica Hungarica, vol. 15, no. 3, pp. 149-173, 2018.

[16] J. Falah, S. Khan, T. Alfalah, S. F. M. Alfalah, W. Chan, D. K. Harrison; V. Charissis, "Virtual Reality medical training system for anatomy education," Science and Information Conference, IEEE Xplore, pp. 752–758, 2014.

[17] R. Hu, Yi-Yong Wu and Chich-Jen Shieh, "Effects of Virtual Reality Integrated Creative Thinking Instruction on Students' Creative Thinking Abilities," EURASIA Journal of Mathematics, Science & Technology Education, vol. 12, no. 3, pp. 477–486, 2016.

[18] Gy. Bujdosó, O.C. Novac, T. Szimkovics, "Developing cognitive processes for improving inventive thinking in system development using a collaborative virtual reality system," In: P. Baranyi (Ed.), Proc. of 8th IEEE International Conference on Cognitive InfoCommunications, CoginfoCom 2017, Piscataway (NJ), IEEE Computer Society, pp. 79-84, 2017.

[19] B. Berki, "Better memory performance for images in MaxWhere 3D VR space than in website," In: Baranyi, P., (Ed.), Proc. 9th IEEE International Conference on Cognitive Infocommunications, CogInfoCom 2018, Piscataway (NJ), IEEE Computational Intelligence Society, pp. 281-284, 2018.

[20] I. Horváth, "Innovative engineering education in the cooperative VR environment," In: Proc. IEEE 7th International Conference on Cognitive Infocommunications (CogInfoCom 2016), pp. 359-364, 2016.

[21] L. Kiss, B.P. Hamornik, M. Koles, P. Baranyi, P. Galambos, G. Persa, "Training of business skills in virtual reality," In: Baranyi, Peter, (Ed.), 6th IEEE International Conference on Cognitive Infocommunications (CogInfoCom 2015), New York,: IEEE, pp. 215-216, 2015.

[22] A. Tarabasz, M. Selaković, Ch. Abraham,. "The classroom of the future: disrupting the concept of contemporary business education," Entrepreneurial Business and Economics Review, vol. 6, no. 4, 231-245, 2018.

[23] A. Gilányi; E. Hidasi, "Virtual reality systems in the rehabilitation of Parkinson's disease," In: P. Baranyi (Ed.), Proceedings of 7th IEEE Conference on Cognitive Infocommunications, Budapest,: IEEE Hungary Section, pp. 301-305, 2017.

[24] M. Yates, A. Kelemen, CS. Lanyi, "Virtual reality gaming in the rehabilitation of the upper extremities post-stroke," Brain Injury, vol. 30, no. 7, pp. 855-863, 2016.

[25] I. Minyaev, M. Pouke, J.M. Ylipulli, T. Ojala, "Implementation of a Virtual Reality Interface for a Public Library," In: MUM2018: Proceedings of the 17th International Conference on Mobile and Ubiquitous Multimedia, pp. 513-519, 2018.

[26] A. Gilányi, M. Virágos, G. Bence, A. Erdős, F. Fejes, "A virtual presentation of the Collection of Rare and Early Printed Books of the Library of the University of Debrecen," In: P. Baranyi, A. Esposito, M. Niitsuma, B. Solvang, (Eds.), IEEE 4th International Conference on Cognitive Infocommunications: CogInfoCom 2013, New York, IEEE Hungary Section, pp. 941-941, 2013.

[27] L. Lopatin, "Library digitization projects, issues and guidelines: A survey of the literature," Library Hi Tech, vol. 24, issue 2, pp. 273-289, 2006.

[28] Y. Quan Liu, "Best practices, standards and techniques for digitizing library materials: a snapshot of library digitization practices in the USA," Online Information Review, vol. 28, issue: 5, pp. 338-345, 2004.

[29] Gy. Bujdosó, M. Csernoch, M. Borbély, E. Dani, M. Nemethi-Takács, K. Koltay, L. Balázs: "LibSearchNet: Library log file initiatives - As a part of semantic library interface development for the VirCA 3D virtual collaboration arena," In: P. Baranyi, A. Esposito, M. Niitsuma, B. Solvang, (Eds.), Proc. of 4th IEEE International Conference on Cognitive Infocommunications: CogInfoCom 2013, New York, IEEE Hungary Section, pp. 567-572, 2013.

[30] A. Faisal, "Computer science: Visionary of virtual reality," Nature, vol. 551, pp. 298-299, 2017.

[31] Z. Cuiyuan, "Research on Digital Library Based on Virtual Reality Technology," Advances in Engineering Research, vol. 149, pp. 101-106, 2018.

[32] Gy. Bujdosó, "Ruza breto a smart virtual bookshelf for e-learning and electronic teaching," In: L. Gómez Chova, A. López Martínez, I. Candel Torres (Eds.), ICERI2014 Proceedings : 7th International Conference of Education, Research and Innovation, Valencia, IATED, pp. 3649-3655, 2014.

[33] A. Gilányi, Gy. Bujdosó, M. Bálint, "Presentation of a medieval church in MaxWhere," In: 8th IEEE International Conference on Cognitive InfoCommunications, CogInfoCom 2017, Piscataway (NJ), IEEE Computer Society, pp. 377-378, 2017.

[34] MaxWhere's website: https://www.maxwhere.com/ The predesigned 3D spaces can be downloaded from https://store.maxwhere.com/

[35] P. Galambos and P. Baranyi, "VirCA as Virtual Intelligent Space for RT-Middleware," In: Proc. IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM), Budapest, Hungary, pp. 140–145, 2011.

[36] A. Gilányi, M. Bálint, R. Hajdu, S. Tarsoly, I. Erdős, "Presentation of the Church of Zelemér in the Virtual Collaboration Arena (VirCA)," In: Baranyi, Peter; Csapó, Ádám; Sallai, Gyula, (Eds.), 6th IEEE International Conference on Cognitive Infocommunications (CogInfoCom 2015), New York, IEEE, pp. 581-582, 2015.

[37] Gy. Bujdosó, "Virtual Reality in teacher training – Developing presentations in virtual reality," In: ICERI2016 Proceedings, 9th International Conference of Education, Research and Innovation, Valencia, International Association of Technology, Education and Development (IATED), pp. 4900-4905, 2016.

[38] C. Sik-Lanyi, "Virtual reality healthcare system could be a potential future of health consultations," In: J. Sápi, Gy. Surján (Eds.) IEEE 30th Neumann Colloquium 2017 (NC), November 24-25, 2017, Budapest, Hungary, pp.15-19.

[39] K. Boros, Gy. Bujdosó, C.M. Novac, O.C. Novac, "E-Health Promotion virtual reality services in MaxWhere VR spaces – design and development," (accepted at 9th IEEE International Conference on Cognitive Infocommunications: CoginfoCom 2019, October 23-25, 2019, Naples, Italy).