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Virtual Reality in Teaching and Learning – Experiences and Opinions of Educators

Abstract

The research problem consisted in the question: "What opportunities and limitations in the use of virtual reality (VR) in education do educators/health sciences specialists notice?".
The opinion on the use of VR in education was formed thanks to a combination of two perspectives of the educators: a learner's perspective (the experience of immersion in VR), and a teacher's perspective (professional experience). Methodological triangulation was employed, with both the quantitative and qualitative perspectives used.
The following tools were employed in the research: The positive and negative emotions scale (SUPIN), version S.20 and the SDVR Questionnaire.
The research was conducted at the Department of Health Sciences of the Wroclaw Medical University in Wroclaw, Poland, between October, 2019 and April, 2020. The research group consisted of 30 people specialising in various areas of health sciences.
Specialists in health sciences believe that VR is a method which can make the process of

education more attractive and facilitate achievement in the areas of knowledge, competences, and skills. The trainings in which educators can experience immersion in VR not only make it possible to generate ideas on how to use the equipment, but they also reduce their concerns as to using it. The realism of the experiences, the positive emotions, the multidimensionality of the images during immersion make it possible to employ VR in various areas of education in which VR may be treated as a means to practice clinical situations in a safe environment, as well as a tool illustrating various realms of knowledge (such as, e.g., human anatomy). What is considered by educators as the greatest obstacle in the popularisation of VR in education is the limited access to equipment. Other difficulties include: adapting software to the subject curriculum, working in large groups, and competences of the educators.

Keywords: Virtual Reality, emotions, education, educators, teaching, learning.

Introduction

The results of a meta-analysis published last year suggest that the interest in research on the use of virtual reality in university education has been rising, particularly over the last few years (González-Zamar & Abad-Segura, 2020). We have mainly been interested in the opportunities and obstacles presented by the use of virtual reality (VR) in health sciences and medical sciences.

Virtual reality is a relatively new technology allowing for the creation of computer-generated environments in which users can "immerse" themselves. Users perceive virtual situations as if they were real. This happens with the use of specialist glasses, headphones, controllers, and motion sensors. VR, which, until recently, was mainly associated with entertainment, has found its use in many other areas, including education (Chen et al., 2016).

When using the technology in education the participants of the education process are not only passive observers. To the contrary, they are expected to participate actively and creatively. At the same time, it ought to be noted that the VR technology does not diminish the role of teachers. They serve the important role of mentors, knowledge experts, and organisers of classes and work. The teachers' knowledge and their experience provide the opportunity to use available technology (Żmigrodzka, 2017).

What appears to be particularly interesting from the perspective of medical science and health sciences is the virtual learning of anatomy (Marks et al., 2017). Students are provided the opportunity to see the inside of the human body in three dimensions; they can zoom in on and turn the parts of the body which they are interested in, as well as seeing them in numerous planes, which is a clear advantage of this technology.

The students using VR can not only get theoretical knowledge, but they can also build their skills. What may serve as an example are trainings for doctors, nurses, and paramedics. Thanks to VR technology, students can be confronted with virtual patients experiencing various ailments as a result of virtual incidents, so that the acquired skills can be practiced repeatedly on avatars, before real-life patients are treated (Rosenthal et al., 2008; Sitterding et al., 2019). Research suggests that it is possible to form social competences, including communication competences, with the use of VR tools (McGovern et al., 2020).

Many higher schools in Poland use the VR method; however, the use and the introduction of new technologies frequently leads to concerns, which may be connected with lack of knowledge about VR and/or lack of ideas about how to use the technology in a most effective way. Knowledge about the expectations and the concerns of the educators will allow for a more effective implementation of the VR technology in the educational process.

In our research we have mostly focused on the following areas:

1. The emotions accompanying the experience of immersion in VR – it is the area connected with the attractiveness of VR, personal impressions of the educators connected with VR equipment, and confronting their own insecurity and doubts.
2. The aims of the use of virtual reality in education – it is the most crucial area in the context of the education process. The importance which virtual reality may have in the realisation of the planned education results in the area of knowledge, skills, and competences has been investigated..
3. Problems and doubts connected with the use of VR – it is the area linked with the identification of obstacles which may hamper the popularisation of VR technology in education
4. The general perception of VR technology – it is the most general area. It has been formulated in a flexible way in order to place maximum focus on the perspective of the educators when describing the problems connected with the use of VR in the context of education.

The aim of the research was to identify the opportunities presented by the use of virtual reality in education, as well as its limitations.

Materials and methods

The research was conducted as part of a project financed with an internal grant of the Wroclaw Medical University. The presented research results realised

as part of the subject have been evidenced in the Simple system under STM. E025.18.020.

The research was conducted at the Department of Health Sciences of the Wroclaw Medical University in Wroclaw, Poland, between October, 2019 and April, 2020. The research group consisted of 30 people (26 women and 4 men) specialising in various areas of health sciences. Since the aim of the research was, first and foremost, to identify the opportunities and the limitations of the use of VR, which was not connected with a generalisation of the results, the criterion of the selection of persons according to the effect of theoretical saturation was the diversity of the experiences of the research participants in relation to education and immersion in VR. The following differences between the research participants were taken into account: length of the professional experience (among the participants there were beginner educators as well as persons with over 20 years of professional experience), the subjects of instruction (linked with science to a greater or a lesser degree, e.g., promotion of health vs pharmacy), and former experience with VR (among the participants there were those who had experienced immersion in VR before, as well as those for whom it was their first experience with VR).

The opinion on the use of VR in education was formed thanks to a combination of two perspectives of the educators: a learner's perspective (the experience of immersion in VR), and a teacher's perspective (professional experience). Methodological triangulation was employed, with both the quantitative and qualitative perspectives used. The intensity of emotions of the research subjects was measured with the use of the questionnaire *Skala Uczuć Pozytywnych i Negatywnych* [Positive and Negative Affect Schedule] (SUPIN), and subsequently they would participate in three VR sessions, after which the subjects were again asked to fill out a SUPIN questionnaire, and then to fill out a *Skala Doświadczania VR* Questionnaire [Virtual Reality Experience Scale] (SDVR), collecting their opinions on the use of VR in education.

The tools employed in the research:

1. Positive and negative emotions scale (SUPIN).

SUPIN is a Polish language adaptation (Brzozowski, 2010) of the PANAS questionnaire (The Positive and Negative Affect Schedule, Watson & Lee,1999). The purpose of the tool is to measure the intensity of positive and negative emotions. A shortened S 20 version of SUPIN was used, consisting of 20 questions and used to measure current emotional states.

1. The SDVR questionnaire (Jakubowska et al., 2019).

The questionnaire consists of 14 positive statements pertaining to the use of VR during classes in the area of knowledge, competences, and skills, as well as the

limitations and opportunities generated by the use of VR in class. The questionnaire also includes two open-ended questions. The first of them pertains to impressions of the educators produced by their participation in the classes, and the second to their opinions on the use of VR in education.

1. Equipment and accessories: a laptop, the Oculus Rift Pro headset, Oculus motions sensors, Oculus Touch motion controllers
2. Statistical analysis was conducted with the use of the Statistica 13.1 PL programme. In the analysis a 95% confidence interval was assumed ($p < 0,05$). Comparative analysis in range of dependent variables on the ordinal scale was conducted with a sign test.

The educators' experience of immersion

The first stage of the research consisted in the educators experiencing immersion in VR. The aim at this stage was to familiarize the educators with the impact of VR and to allow them to look at VR from the perspective of a learner. The educators presented their impressions and their assessment of the use of VR in the questionnaire pertaining to the use of VR. What is more, the influence of VR on the educators was measured with the emotions test, which was filled out by the research subjects at the start of the VR session and immediately afterwards (Table 1).

Table 1. Comparison of the SUPIN S20 results before and after the VR session.

Emotions	N	Percent v < V	Z	p
Active	24	91.67	3.878	0.000
On pins and needles	19	47.37	0.000	1.000
Powerful	20	80.00	2.459	0.014
Irritable	16	56.25	0.250	0.802
Agitated	20	90.00	3.354	0.001
Eager	18	88.89	3.064	0.002
Scared	19	68.42	1.376	0.169
Jaunty	17	82.35	2.425	0.015
Strong	18	66.67	1.178	0.238
Firm	23	73.91	2.085	0.037
Guilty	3	66.67	-0.000	1.000
Afraid	18	66.67	1.178	0.238
Fearful	13	76.93	1.664	0.096

Table 1. Comparison of the SUPIN S20 results before and after the VR session.

Emotions	N	Percent v < V	Z	p
Anxious	21	38.09	0.873	0.383
Embarrassed	11	36.36	0.603	0.546
Decisive	16	87.50	2.750	0.005
Nervous	15	73.33	1.549	0.121
Worried	13	53.85	-0.000	1.000
Brisk	23	86.96	3.336	0.001
Alive	20	80.00	2.459	0.014

Source: Authors' research.

The research results have shown statistically significant differences be-tween measurements of such emotions as: active, powerful, agitated, eager, jaunty, firm, decisive, brisk, and alive. Thus, 9 out of 10 positive emotions in-cluded in this scale have increased after the educators experienced VR.

Specialists' opinions on the use of VR in education

The SDVR questionnaire was employed to check the educators' opinion about VR in three areas: the aims of the use of VR, the problems/concerns connected with the use of VR, and the general perception of VR equipment.

The aims of the use of VR
The didactic process includes the formulation of aims and the expected results as to the areas of knowledge, competences, and skills. That is why it was chec-ked whether the educators see an opportunity to employ VR in all these areas. It was assumed that educators would see the greatest advantage of VR in the areas of skills, and that they would consider traditional means to make the transfer of knowledge easier than VR. Furthermore, it was assumed that the effective-ness of VR in the area of competences/change of attitude would be perceived as the lowest. The research has shown that the educators see the usefulness of VR in the realisation of all the areas of the aims. However, it can be concluded from the research results that it is the opinion of the educators that VR can be the most effective in relation to knowledge (94% of the research participants). The remaining areas occupied the second position, with 77% of the educators perceiving VR as helpful in developing skills, and 74% as effective in the area

of attitudes. What is important is that 64% of the research subjects did not agree with the statement that traditional didactic means are better in achieving results in the area of knowledge than VR.

In order to identify areas not included in the questionnaire, the research subjects were also asked open-ended questions. By coding the answers to the open-ended questions three main areas of the use of VR have been outlined:

a. Reduction of distance: the opportunity to see new places and cultures
b. Simulation: training in situations of conflict, in problem situations; training medical services
c. Spatial education: anatomy, natural phenomena.

All the subcategories can be coded into a general category, which has also been shown in the answers: the opportunity to experience something which due to difficult situations, distance, or other factors cannot be experienced in reality.

Problems/concerns connected with the use of VR

It was assumed that concerns connected with the use of VR equipment would pertain first and foremost to technical problems, the sense of a lack of competences among the educators, as well as the fact that the equipment is typically used individually, and university classes are usually organised in large groups. From the research it can be concluded that the greatest difficulty is the availability of the equipment: 54% of the research subjects believe that this constitutes the greatest obstacle in widely using VR in education. A lower number of the educators pointed to other areas: 30% agreed with the statement that the equipment can cause problems in class, and 37% maintained that the inability to use the equipment with a larger group of students might constitute a problem.

What is important to note is that all the research subjects agreed with the statement that the VR method is proper for all age groups. 64% of the educators believe that VR equipment is safe and that they would be able to use it in class.

The following three areas of difficulties were coded from the answers to the open-ended questions:

• Competences of educators: the necessity of trainings;
• Adjustment to the curriculum: difficulties in adjusting to the curriculum, to the specifics of a given subject;
• Specifics of the equipment: difficulties in working with numerous persons.

Perception of VR

It has been assumed that the educators, in spite of their positive evaluation of VR equipment, would be inclined to perceive VR as part of the realm of entertainment rather than education.

The results have shown that it is the domain of VR to make the education process more attractive. 90% of the research subjects agreed that VR in fact makes the process of education more attractive, which constitutes a very high percentage. 95% of the educators believe that the VR session provided them with positive emotions, which is confirmed by the measurement of emotions during the pre- and post-tests. It ought to be emphasised, however, that despite this approach the educators did not consider attractiveness as the only aspect of VR. Only 24% believe entertainment to be the main aim of VR, rather than transferring knowledge.

The experiences mentioned by the educators in their answers to the open-ended questions have been coded into three areas:

1. Experiences during immersion
   • Emotions: experiencing positive emotions such as: joy, excitement, pleasure, fascination, fun;
   • Realism: experienced realism, the opportunity to experience something which is difficult to experience in reality
   • The power of impact: agitation, engagement, intensity, effectiveness of the stimuli, energy
2. Sensations before and after the immersion:
   • Insecurity: concerns, anxiety, stress before using VR
   • Reduction of insecurity: willingness to take part in a VR session again

One ought to note the last area which emphasises the essence of educator trainings. What can be concluded from the answers coded into sensations before and after immersion is that the experience of immersion in VR not only makes it possible to generate ideas on how to use the technology, but also leads to the reduction of concerns connected with its use.

Discussion

On the basis of the conducted research it can be concluded that most of the research subjects express the conviction that VR increases the effectiveness of teaching. VR technology can be employed in trainings of cognitive functions connected with remembering and understanding information as well as acqu-

iring spatial and virtual knowledge. VR facilitates improvement of psychomotor functions, as well as affective ones, responsible for controlling emotional responses.

Increased emotional reactions and the sense of experiencing contribute to the improvement of remembering. The conducted research has demonstrated that VR influences the emotions of the educators by reinforcing positive emotions. During the sessions users have the opportunity to immerse themselves in a virtual environment. They can see things and experience situations which could not be observed to such extent in the real world. Schone, Wessels, and Gruber (2019), when comparing immersion with watching films, point out that the situations experienced in VR become part of the autobiographical associative network, while conventional video experiences remain separate incidents.

It ought to be noted that not all research confirms the increased effectiveness of learning with the use of VR in comparison with other didactical means.

Some studies show that while VR positively influences the attitude towards learning, better results in the area of knowledge are achieved by those using video materials (Sung et al., 2021). Corresponding results have been produced by other studies, where learning with the use of simulation in VR conditions and the conditions of live simulations were compared. It has turned out that although a development of didactic knowledge was observed for all the participants in the trainings based on simulation, the participants in live simulations achieved higher test results after the training when compared to participants in VR simulations (Ke & Xu, 2020). Nevertheless, it ought to be noted that such live simulations are not always feasible; what is more, there are areas where increased engagement in learning, and in acquiring knowledge and experience, provided by VR can be more effective than that achieved with traditional means (Sholihin et al., 2020).

One of the main advantages of using VR in teaching in medical studies may be the
 improvement of safety and quality of life of patients as well as students. VR makes it possible to get to know and to practice procedures, limiting the stress of the students, who have the opportunity to practice on avatars rather then real-life patients. In the learning process they quickly receive feedback on what has been conducted properly, and what needs to be improved, which undoubtedly constitutes yet another advantage.

It was also the aim of our research to identify obstacles. The conclusion can be drawn from reference sources that many doubts of the educators may result from insufficient promotion of the VR method. Research shows that such obstacles may be: the lack of support from administrators of higher schools, lack

of information and practical trainings for students, and the lack of awareness of the virtual education system among those managing higher schools (Ahmadi & Nourabadi, 2020). Yet, another significant problem which arises in most studies, including our research, is the difficult access to and the costs of the technology. Research conducted in South African higher schools shows that differences in the socio-economic status of students may result in unequal chances in benefitting from the opportunities provided by VR (Matome & Jantjies, 2019).

One of the doubts mentioned by educators participating in our research was connected with the problem of adapting VR technology to the specifics of the given subject of study. It ought to be emphasised, however, that the virtual environment can be modified throughout the teaching process, which means that parameters can be adapted to the desired educational outcomes or individually to the person conducting the experiment by, e.g., adapting to the level of knowledge/skills of an individual student (Hubbard et al., 2017).

It is crucial, however, to carry out further research into whether the experience gained in the virtual world is reflected in skills presented in clinical practice. Thanks to VR students at medical universities have the opportunity to prepare themselves for their future profession initially by learning human anatomy in the virtual world, through observing surgeries thanks to 360-degree video cameras, to experiencing surgery and medical procedures in a simulated environment. Events in the virtual world are a reflection of events which can in fact be encountered in clinical practice. Simulation, including the virtual one, allows students to realistically imagine a given situation, creates conditions allowing for the acquisition and practising of skills; nevertheless, further studies are necessary (Grantcharov et al., 2005; Panczyk et al., 2016). Parong and Mayer have demonstrated positive attitudes of students towards using VR in modern teaching. It increases students' motivation and engagement more than multimedia presentations (Parong & Mayer, 2018; Sharma et al., 2018). The majority of the investigated educators are also of the opinion that VR makes the education process more attractive. The attractiveness of teaching with the use of VR results from the three-dimensional character of the environment, interaction, as well as increased realism and the opportunity to immerse oneself (Velev & Zlateva, 2017).

Unfortunately, in spite of the numerous advantages of the technology, unwillingness to employ VR in education is still observed. This is typically the attitude of persons who accept traditional teaching methods, but not exclusively. The investigated educators also expressed many concerns as to the use of VR in education, including: low competences to use VR, unavailability of the neces-

sary equipment, and the potential technical issues which may arise when using the technology in class. Employing VR can, in the opinion of the educators, present a technological challenge, just as in the case augmented reality (AR) (Dunleavy et al., 2009). Frequently the reason why VR is not used in class is educators' lack of knowledge about the advantages of the technology or lack of ideas as to how to employ such didactic means.

It is still mostly young people who reach for VR, and it is mostly for the purpose of entertainment. Up to 50% would like to use VR in education. However, their lack of experience and the lack of applications dedicated to learning constitute an obstacle in employing VR in the education process (Sánchez-Cabrero et al., 2019).

Nevertheless, as Martín-Gutiérrez et al. (2017) point out, due to its significant opportunities and potential, VR is going to increasingly change the face of formal education.

Some higher schools also employ VR in remote learning (Ghanbarzadeh & Ghapanchi, 2018). When taking into account how energetically this learning method has recently been developing, researching this subject appears particularly promising.

Conclusions

To sum up the results of our qualitative and quantitative research, the following conclusions can be formulated:

- It is the opinion of health sciences specialists that the VR method can be employed effectively to achieve goals in the areas of knowledge, skills, and competences.
- The VR method is versatile enough to be used with diverse age groups.
- The educators' experience with VR contributes to increase in positive emotions, to generating ideas on how it can be used, and to reduction of concerns related to the use of such equipment in education.
- The greatest obstacle in popularising VR in education is access to equipment. Other difficulties are: adaptation of the software to curricula and the specifics of a given subject, working in larger groups, and educators' competences.
- Thanks to the sense of realism during immersion, according to the educators, VR allows for the reduction of geographical distance, simulation of experiences in natural sciences, as well as spatial education (learning human anatomy).

Certain limitations of the research also ought to be mentioned. The research was aimed to, first and foremost, identify the opportunities provided by and the limitations of the use of VR in education. Mainly the qualitative research was used for this purpose. Information collected and analysed with the quantitative method constituted a supplement. In case of the latter perspective the number of persons and their distribution were insufficient to generalise the results for the entire population. The results produced with the quantitative method ought to be considered preliminary. In order to verify them, it is required that the research be replicated with a larger, randomly selected sample.

It is also worth to carry out further research investigating the effectiveness of the use of VR in knowledge acquisition. Although it was the opinion of the educators participating in our research that VR may be effective in this area, some results of the post-tests show that students using VR achieve lower results in comparison with students learning with the use of other didactic methods.

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