A photograph of an operating room with several surgeons in teal scrubs and masks. The image is partially obscured by a teal overlay on the left side where the title is located.

HANDBOOK OF SOFT SKILLS TRAINING USING VIRTUAL REALITY AND SERIOUS GAMES FOR SURGICAL TEAMS IN THE OPERATING ROOM

S4Game Consortium



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3. USE OF VIRTUAL REALITY AND SERIOUS GAMES FOR SOFT SKILLS

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STATE OF ART OF VIRTUAL REALITY

Virtual reality (VR) is a technology that, although it is not a new technology (its first developments date back to 1960), is in full swing and is settled in the general consumer market.

It is a computer technology that aims to simulate an environment, either real or imaginary, and translocates the user inside. This user will have a physical presence within that environment, being able to interact with it. Virtual reality tries to create complete sensory experiences.

The main features of virtual reality are:

1

COMPUTER GENERATED GRAPHICS: all information received by the user is processed by computer.

2

SIMULATED 3D ENVIRONMENT: a virtual environment is generated to which the user is transferred.

3

IMMERSION AND USE OF THE SENSES: the simulation goes beyond the physical representation of the environment. VR offers immersion through sounds, touch and even smell (Canepa, 1997).

4

INTERACTIVITY: the environment responds to the actions and movements of the user.





Virtual reality devices have reached the general consumer. Since 2012, in which Palmer Luckey developed and financed through Crowdfunding his Oculus Rift, obtaining more than 10 times what was required in its collection (2.4 million dollars) (Engadget, 2004), the number of devices has grown rapidly. This has been possible thanks to a decrease in the development costs of the devices and the force generated by their demand and expectations of the general public.

There can be considered two types of technology in the use of VR today. The first is more advanced and complete:

HEAD MOUNTED DISPLAY (HMD) STAND-ALONE. These helmets hinder the user's vision and display two screens (one for each eye) in which the visual information of the three-dimensional world is sent. The screens send a different image to each eye in such a way that the user visualizes the environment stereoscopically and generating depth perception, just like in the real world. The helmet has advanced sensors to transfer the movement of the user's head to the virtual world, allowing precise and complete interaction.

MOBILE VR. These are helmets that use mobile phones to visualize three-dimensional worlds and uses its gyroscope to interact with the environment. It obtains an intermediate level of investment, since the sensors and the screens do not have the improvements of the previous devices.

Figure 3.1 shows a comparison among several devices that are currently on the market that belong to the first type of VR devices.

PRODUCT	OCULUS QUEST	NINTENDO LABO VR KIT	SONY PLAYSTATION VR	HTC VIVE	OCULUS GO	OCULUS RIFT S	HCT VIVE COSMOS	LENOVO MIRAGE SOLO WITH DAYDREAM
								
	\$399.00	\$79.99	\$276.99	Best Price	\$199.00	\$399.00	\$699.99	\$299.00
BEST FOR	VR Newbies and Gamers	Nintendo Switch Owners	PlayStation 4 Owners	Stream Gamers	Curious VR Newbies	PC VR Users	Dedicated PC VR Fans	Google Daydream Users
HEADSET TYPE	Standalone	Mobile	Tethered	Tethered	Standalone	Tethered	Tethered	Standalone
CONNECTIONS	None	None	HDMI, USB 2.0	HDMI, USB 3.0	None	DisplayPort, USB 3.0	DisplayPort, USB 3.0	None
RESOLUTIONS	1,444 by 1,600 (per eye)	1,280 by 720 (total)	960 by 1,080 (per eye)	1,080 by 1,200 (per eye)	1,280 by 1,440 (per eye)	1,280 by 1,440 (per eye)	1,440 by 1,700 (per eye)	1,280 by 1,440 (per eye)
REFRESH RATE (HZ)	72	60	120	90	72	80	90	75
MOTION TRACKING	6DOF	3DOF	6DOF	6DOF	3DOF	6DOF	6DOF	6DOF (3DOF controller)
CONTROLS	Oculus Touch	Joy-Cons	DualShock 4, PlayStation Move	HTC Vive motion controllers	Oculus Go Controller	Oculus Touch	HTC Vive Cosmos motion controllers	Daydream Controller
HARDWARE PLATFORM	Android	Nintendo Switch	PlayStation 4	PC	Android	PC	PC	Android
SOFTWARE PLATFORM	Oculus	Nintendo Labo	PlayStation 4	Steam VR	Oculus	Oculus	Steam VR	Google Daydream

Figure 3.1. VR Headsets of 2019 (Pcmag, 2019).

This technology has evolved exponentially in recent years, with 2019 being an important year which has been a inflection point. The cause of this milestone is the release of different virtual reality glasses of high resolution and immersion capacity, completely wireless and with a lower and affordable price for the general public.

These VR headsets can be used in turn with a series of devices that enhance experiences. Leap Motion is a motion sensor capable of capturing gestures made with the user’s hands. This achieves an interaction between the user and virtual reality making possible a new user experience different from the traditional one, through the keyboard and mouse. Another of the advances are the VR walkers. They are similar to gymnastics walking belts, which allow users to move safely and freely in any direction, which facilitates 360 ° movements. The most widespread platform is Virtuix Omnique, which has a concave shape where users’ feet rest and where they slide as they walk. User movements can be limited by a safety harness with which to avoid any accident (Figure 3.2).



Figure 3.2. Virtuix Omni Platform. (www.vituix.com).

STATE OF ART OF SERIOUS GAMES

A “serious game” is defined as that game which purpose is different from entertainment. Serious games are intended to simulate a real environment or event of any field and offer the user an interaction or reception of information through it.

Following the above definition, serious games can be distinguished from video games in that the main objective is not entertainment. This causes conflict for some authors (Jantke, 2010; Michaud, 2008; Ritterfeld *et al.*, 2009). These sources determine that the term “serious” comes from the role of the game of bringing experiences to the user, be it a message, information, knowledge, skills or general content; that is exposed to an environment that shows information through such experience or know-how, but that should not be removed from the definition of the first term: “game”.

A game is considered as the union of three components: experience, multimedia and entertainment, as shown in **Figure 3.3**.

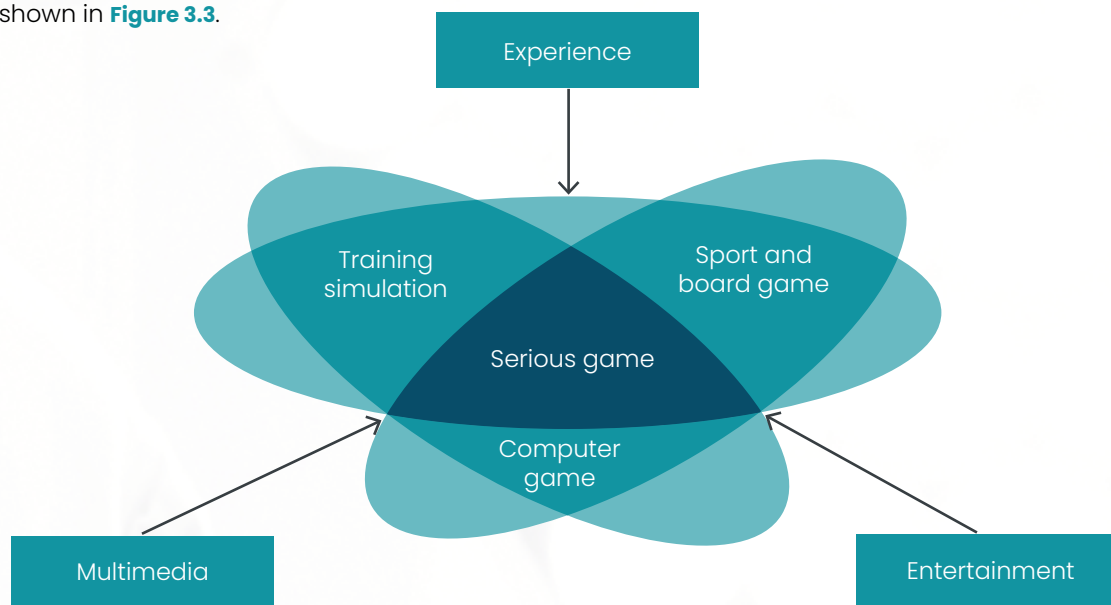


Figure 3.3. Serious game components.

Modern learning theories suggest that learning is most effective when it is active, experimental, problem-based and provides the user with an immediate response (Boyle *et al.*, 2011). Although experience is the fundamental pillar of serious games, it is therefore necessary to rely on multimedia and entertainment to be really effective.

Through serious games, students can develop soft skills, such as analytical skills, strategic thinking, decision making and communication (Susi *et al.*, 2007). It is also possible to use a multi-player game, with which to train teamwork competitions (Prensky, 2003).

It is worth noticed that the number of serious games published in the last 10 years has been multiplied by four (Michaud, 2010; Laamarti *et al.*, 2014).

Serious games have wide application in the field of medical training, where they are mainly related to the acquisition of theoretical knowledge and skills training (Asociación Española de Empresas Productoras y Desarrolladoras de Videojuegos y Software de Entretenimiento, 2015). They have great potential because they allow you to gain experience in risk-free environments (Akl *et al.*, 2013) for both medical staff and patients. In addition, because serious games have a global audience, they can contribute to transforming the traditional education of health professions.

The following is a summary of 3 systematic reviews carried out between 2016 and 2019 by different authors, whose purpose is to evaluate the effectiveness of serious games in the field of health compared to traditional learning.

In (Wang *et al.*, 2016), 42 articles of serious games applied in the field of health are identified and studied among more than 3,737 publications of serious games from different sectors. These serious games focus on health fields as different as geriatrics, nursing, radiography or neurology, among others. The study shows that most of the serious games reviewed (79%) propose to evaluate the “player” learning process. However, in most cases they do so in a lacking methodological approach and without a good evaluation design.

In a more recent study, Gorbanev *et al.* (2018) reduce to 21 the number of articles found on serious games or gamified applications in the field of health from a total of 494 identified publications. Of these studies, 16 are focused on knowledge and skills and the remaining 5 on satisfaction, attitudes, perceptions or opinions. For the most part, these studies used quantitative tools, such as surveys, and qualitative, as open-ended questions for the evaluation of learning. However, only 28.5% of the instruments had evidence of internal validity. Despite these methodological limitations, the statistical analyses used are correct (90.4% of cases) and measured objectively 76.1% of the time. This article concludes that serious games evaluated should be used as complementary tools of ordinary training. According to the Medical Education Research Study Quality Instrument (MERSQI) scale, it is not ensured that serious games are effective to a large extent despite the authors claiming that they are very useful pedagogical tools. Its effectiveness will depend on the quality, robustness and the good design of the educational game and the evaluation system.

In the revision by Gentry *et al.* (2019) 30 studies of a total of 30,532 citations are evaluated. 15 of the reviewed works compare educational games versus traditional learning, the results being inconsistent and generally with poor quality studies. However, the results of this research show that serious games can generate more knowledge, skills and satisfaction compared to traditional education.



BENEFITS OF USING VIRTUAL REALITY AND SERIOUS GAMES FOR SOFT SKILLS TRAINING

The characteristics described the previous section show VR as a tool with great potential in the world of Serious Games, and in particular for the training of soft skills. It has enough capacity to represent simulation environments for medical training in a virtual environment.

Virtual reality can be applied in two different ways in all fields and more specifically in the training of soft skills in the field of health:



1

CONTENT GENERATION THROUGH VIDEO. A recording is made with a 360° camera (Figure 3.4). The video is watched through an HMD or Mobile VR, which provides learning through vision. The user's interaction method is very simple, because in most cases it only recognizes the movement of the head through a gyro.



Figure 3.4. 360° Camera y Mobile VR from Samsung.

2

INTERACTIVE 3D CONTENT GENERATION THROUGH SOFTWARE DEVELOPMENT. (Figure 3.5) It allows the user to have a greater sensory experience, being able to touch objects, walk in different scenes, and wear gloves, suits or headphones.



Figure 3.5. CCMIJU professional experiencing VR.

Both methods present virtual reality as a provider of unique experience, which justifies its use for training soft skills in the field of health (Ruiz-Parra *et al.*, 2009; Flanagan *et al.*, 2004; Pugh and Salud, 2007; McLaughlin *et al.*, 2002; Ypinazar and Magolis, 2006):

- It improves the acquisition and retention of knowledge compared to other traditional methodologies.
- It allows the planning and development of clinical cases based on the needs of the student and not on the availability of the patients.
- It allows for different users to interact with the same scenario, offering similar opportunities for learning through the comparison of the result.
- It offers the opportunity to deepen non-technical skills: work aspects such as teamwork, communication skills, leadership, stress management and decision making.
- It offers the opportunity to meet and use real equipment and instruments.
- It reduces the cost, since training in the operating room and other rooms is expensive and often scarce resources.
- It allows the collection of quantitative data of each of the users participating in the execution, what will produce statistical analysis to obtain a feedback to the user and subsequent clinical studies.



The measurements that can be made in the serious game of soft skills in health with virtual reality can be either technical or feedback for the user. As for technical, we mean automatic and objective measurements that the software automatically performs, for example:

- Learning time using virtual reality.
- Movements performed within the scenario.
- Main elements and characters the user is looking at.
- Time required to interact back when talked to.
- Which method of selecting dialogue options is more appropriate.

Those that are performed for the user come from certain psycho-pedagogical studies that try to evaluate non-technical skills. This feedback can be generated automatically through the software through a set of rules, or by a professional who analyses (either in real time or later) how the player has acted and what dialogue choices he/she has selected.

An important decision that should be evaluated is to offer feedback only at the end of the game session or interrupt the game when deemed necessary to give an evaluation.

In (Hays *et al.*, 2013), it is studied whether the course of the game should be interrupted to give feedback to the user. One way to increase the pedagogical value is to use an intelligent tutorial system (ITS) to provide feedback during the game. Some researchers have expressed concern about the fact that, because feedback from an ITS is often extrinsic (that is, it operates outside the main game mechanics), it alters the players' sense of presence. As a result, learning can be involuntarily hindered due to this ITS.





LIMITATIONS OF VIRTUAL REALITY AND SERIOUS GAMES

Among the disadvantages that are found when using virtual reality for this type of serious games are:

1

Despite the fact that prices of virtual reality devices have decreased, for certain professionals it can be a cost that cannot be assumed.

2

For some people, virtual reality can be an added difficulty and even rejection in the elderly. They can generate dizziness and disorientation, which would introduce many errors in the collected data.

3

Depending on the model of glasses used, it is necessary to place exactly the elements of the tool (cameras, sensors, infrared, etc.), which complicates the installation of the system and makes it difficult to move.

4

There are currently many virtual reality devices that use different technologies, which makes the development completely different for each of them.

5

Another of the pedagogical / technological challenges is to "replace" the coach of a face-to-face training session, with an online "coach" always available.

6

Virtual reality systems offer a new dimension of interactivity and immersion by offering the user to move to a three-dimensional environment. But this improvement in immersion has an obvious consideration: the representation of the environment in which the user finds must be more faithful to reality than a conventional 3D application, since a break with the immersion could easily occur if the representation is not adapting to user expectations.

The research carried out during this project must answer these questions, giving a result that allows users of virtual reality to recognize verbal language in other characters and people effectively.