ABSTRACT

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Abstract

Immersive virtual reality is any computer-generated environment capable of fooling the user's senses with a feeling of presence (being there). Two different types of hardware are usually used to access immersive virtual reality: Head Mounted Displays (HMD) or Cave Automated Virtual Environment (CAVE).

Due to its ability to generate any kind of environment, either real or imaginary, immersive virtual reality can be used as a tool to deliver experiential learning, as described by Kolb (1984) in his experiential learning circle model. Such model identifies four different steps that, as part of a circle, describe the process of learning by experiencing something, these steps are: (1) concrete experience, (2) observations and reflections, (3) formulation of abstract concepts and generalization, (4) testing implications of concepts in new situations.

Immersive virtual reality has been out for decades, but in spite of the big buzz around it, a large adoption of the technology has not occurred yet. One of the main barriers to adoptions is the high cost of gear needed. However, recent development in technology are pushing prices down. For instance, Google Cardboard offers a very inexpensive way to experience virtual reality through smartphones. Moreover, the price of HMD and the powerful computers needed to run virtual reality software are expected to fall as it already happened with desktop computers before.

The Technology Acceptance Model (TAM), as introduced by Davis (1989), is an attempt to understand the factors behind the adoption of new technologies. In particular, this model introduces the two key concepts of (1) perceived usefulness and (2) perceived ease of use. Looking at these, the manuscript attempts to bring some light in the current state of the adoption. The findings of this study have both theoretical and managerial implications, useful both to schools and vendors.

The main finding of this study is that more research is needed to understand how people learn in immersive virtual reality, and how to develop software capable of delivering experiential learning. A tighter collaboration between schools, students, manufacturers, software developers seems to be the most viable way to go.

Key words	Immersive Virtual Reality, Head Mounted Display, HMD, Cave Automated Virtual Environment, CAVE, Experiential Learning, Technology Acceptance model, TAM. Perceived Usefulness, Perceived Ease of use

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IMMERSIVE VIRTUAL REALITY FOR EXPERIENTIAL LEARNING

Master's Thesis
in International Business

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1 INTRODUCTION

This chapter presents the research. It firstly exposes the research questions, and secondly introduces briefly immersive virtual reality, experiential learning and the technology acceptance model.

1.1 The Research

Some literature review on the state of virtual reality exist already (Radianti et al. 2020; Wang et al. 2018; Kavanagh et al. 2018; Chuah 2018). However, none of these focuses on the acceptance model as perceived by VR users. The author believes TAM to be the most reliable tool to understand how users perceive immersive VR, and therefore their willingness or unwillingness to accept this technology. Strong evidence supports the idea that VR will become mainstream at some point. When exactly this will happen, nobody knows. Previous experiments, done in education and training brought very promising results. Of course, most depends on the main stakeholders and toward what direction their decisions will be oriented. Vendors have the interest to communicate the real value proposition of this technology to the institutions that deliver education, both public and private schools. These, after reviewing their budgets, will decide whether make the final purchase or not. But in the very end, final users, both teachers and students, are the ones who have the ultimate power to welcome or reject VR. This study looks at them directly. There are good reasons to believe that immersive VR is capable of delivering experiential learning, reproducing realistic experiences from which learners can grasp much more that they would otherwise do using more traditional means, such as reading textbooks or attending lectures. Based on this, the research question tries to dig into the reasons behind the value offered by immersive VR for experiential learning.

Therefore, the main research question (RQ1) is:

RQ: Why VR and immersive technologies are viable tools to deliver experiential learning?

This study tries to find a link between VR, immersive technologies and experiential learning and then, draw an analysis. The author tries to investigate the factors that led to the adoption of such technology in the first place, with a closer look to the educational goals behind it. Ultimately, this would lead us to understand the use of VR for experiential learning, from the point of view of its users, and especially how they perceive it. This study relies on the Technology Acceptance Model (TAM), which measures both Perceived Usefulness (PU) and Perceived ease-of-use (PEU) (Davis, 1989). The technology acceptance theory offers a clear and intuitive support for the purpose of understanding the acceptance of the new technology. Therefore, the main attention is on these two factors: perceived usefulness and perceived ease of use.

To answer the research question, it is important to understand the reasons behind the choice of starting using VR in the first place. It is important to notice that usefulness is perceived by the user. It is therefore a subjective opinion, never an objective reality. Nevertheless, a sufficient amount of data would pinpoint some trends that show the big picture and ultimately would enable us to draw conclusions.

The other key point in the technology acceptance model is perceived ease of use. Here, ease means the lack of difficulties in using a new system. Again, looking at a large enough amount of data, reporting users' impressions this study tries to find the common patterns among users. The subject of study in the research are end-user (teachers and students). Based on their impressions on how useful it is to use VR, and on the good it brings, in addition to the lack of difficulties, this study ultimately aims to find out why VR is a tool capable of effectively deliver experiential learning. This study contains both primary and secondary data. I initially interviewed one leading expert in the field, who provided us with many useful insights and gave us direction for how to conduct the research (Kauer, interview 2019). After that, I searched the existing literature, trying to focus on the publications most relevant for the study. In doing this, I accessed three different databases (World of Science, IEEE and Scopus). By entering the search query "immersive virtual reality experiential learning" I gathered a total of ninety-five (95) articles. Finally, utilizing the software NVivo, I coded the contents, according to the criteria preset for the study. The following chapters present the results of the work. After covering in detail all the relevant literature, I describe the process adopted for the research (methodology) and finally I expose the findings of the work.

1.2 An immersive glance into the state of educational VR

Immersiveness is an important element of virtual reality applications. The online Oxford dictionnary defines "immersive" as something "that seems to surround the player or viewer so they feel totally involved in the experience, often by using three-dimensional computer images" Immersive virtual reality (immersive VR) presents a computer generated environment that convincingly replaces the real world of users, thus providing a sense of immersion into the virtually created world. In other words, immersive VR fools the senses and makes the user feel part of the virtual world (Chuah 2018, 3). The degree of immersiveness can be measured on a scale or continuum, (discussed in chapter two) ranging from non-immersive to fully immersive. User engagement varies accordingly to the degree of immersiveness, although some individual differences shape the experience for each user (Mills et al. 2019, 10). The most developed immersive VR environment are also interactive, enabling the continuous exchange of information between a user and VR environment. Immersive VR can be accessed through two different types of hardware: head mounted displays (HMD) or Cave Automated Virtual Environment (CAVE). The former consists of a display mounted on top of the user's eyes, showing the images of the computed generated world and two headphones reproducing the sounds. The latter is a room with all walls, ceiling and floor covered by displays, enabling the user to physically enter the virtual environment (Schott and Marshall 2018, 26).

As today, the costs of VR gear as well as the powerful computers needed to run its software remain high (Radianti et al. 2020, 45). Such barrier has so far prevented a wider adoption of VR technology by the big public. Both tech and education experts agree that the potential for VR in education is outstanding. However, such gear remains an unaffordable luxury for most schools and universities (Kauer interview 24.7.2019). As a rule of thumb, prices fall when a technology goes mainstream. In spite of the big excitement around VR, there is still a lack of research on how people learn in a virtual environment. This is something Kauer stressed many times during the first interview, and also during the second meeting at Stanford in October 2019, of which there is no record (Kauer interview 24.7.2019). Although commercially unsuccessful, VR has been proven to be very useful in education (Farshid 2018, 12). The main benefits range from an increased time-on-task, enjoyment, motivation, deeper learning and long-term retention. This convinced us and motivated the work to investigate the topic further, although adoption of VR in education remains very low (Kavanagh et al 2017). A study conducted in 2019 in Germany elucidates the current state of diffusion of the technology. Almost the totality of people interviewed (76,6%) said to be familiar with the concept of VR, hence they heard about it somewhere. The number of those who tried on, at least once, a Head Mounted Display (HMD), the main gear to experience VR, is worrisomely low, only 8,7%. But even more astonishing is the number of owners of such equipment, only 1,4% of the interviewees. In spite of the numerous positive forecasts made by tech experts, VR takeoff as a mainstream technology remains yet to be seen (Herzy and Rauschnabel 2019). Nevertheless, some encouraging signs appear on the horizon: (1) VR hardware sales soured by 25.5%, compared between the second quarters of 2016 and 2017 (International Data Corporation, 2017); (2) experts predict the VR hardware market will grow at a compound annual growth rate (CAGR) of 56.1% from 2017 to 2021, the total number of units sold would therefore jump from13.7 million in 2017 to 81.2 million in 2021 (International Data Corporation, 2017). (Manis and Choi 2019, 503).

The author sees VR as a perfect match for delivering experiential learning. The main focus of this paper is in fact the use of VR for experiential learning. A tremendous number of VR applications already exists out there, research shows. For example, VR has been used to a large number of applications, such as remote surgeries (Marescaux & Rubino, 2005) rescue training (Bailie et al., 2016) design cars' interiors (Zimmermann, 2008). From these studies, it clearly emerges that education is the most prevalent use of VR. In facts, the high level of compatibility of VR systems with educational goals offers a remarkable opportunity for both learners and teachers. Zhigeng Pan, et al. (2006) foresees a glorious future for VR applications in the more and more globalized market of education and training.

Kolb (1984, 21) defines experiential learning as: "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combinations of grasping and transforming the experience". In his study, Kolb identifies four different steps that are part of the experiential learning circle: (1) concrete experience, (2) observations and reflections, (3) formulation of abstract concepts and generalization, (4) testing implications of concepts in new situations. The experiential learning theory is discussed in chapter two.

The main theoretical framework used in this study to understand the current and future adoption of immersive VR in education is the technology acceptance model (TAM), introduced by Davis (1989). This theory is an attempt to understand the factors behind the adoption of new technologies. In particular, this model introduces the two key concepts of (1) perceived usefulness and (2) perceived ease of use (Davis, 1989, 3). Looking at these, the manuscript attempts to bring some light in the current state of the adoption. The findings of the study have both theoretical and managerial implications, useful to all main stakeholders involved: educational institutions, software developers, hardware manufac-tures and vendors. The ultimate beneficiaries of such innovation are users, hence teachers and students, whose role includes the pivotal task of assess, evaluate and support the de-velopment of this technology in a way that enhances their performance, boosting knowledge retention and granting an enjoyable experience overall.

At the end of the interview, Kauer (2019) admitted being extremely excited about the technology. But he also stated that as always innovations take a very long time to become mainstream, in fact much longer than people think. Nevertheless, the impact of innovation is astonishingly big, much bigger than most people realize. It has happened already with personal computers and mobile phones, and will surely happen with VR as well. With his words in mind and a hopeful look at previous developments, the author intends to conduct the research.

1.3 Why a literature review

Recent years have seen a remarkable surge of knowledge in both business and technology fields. (Snyder 2019, 333) Such a vast amount of information needs to be assessed and organized. A literature review attempts to achieve this goal. With the current massive number of publications in VR, and newer published all the time, it can be sometimes difficult to remain up to date with the latest information available. Although some litera-ture review on the state of VR have been conducted already (Kavanagh et al 2017; Wang et al. 2018; Chuah 2018; Radianti et al. 2020), none of them is focused on both experien-tial learning and the technology acceptance model. In fact, educational uses of VR have been studied, but the focus on the experiential part of it remains marginal (Kauer inter-view 2019). The same is true for the technology acceptance model, which I believe to be the most accurate barometer to assess people’s attitudes towards new technologies. For all of these reasons, I believe that the review is needed as it brings new information to the previous research.

The ultimate goal of this paper is to bring some light on the current state of research on VR for experiential learning, and possibly give direction to future researchers. The process of conducting a literature review can be divided in four steps: (1) review design, (2) conduction of the review, (3) analysis and (4) writing. (Snyder 2019, 336)

The process of the review is discussed in greater detail in the methodology chapter, the figure below only briefly summarizes all the steps taken in this work.

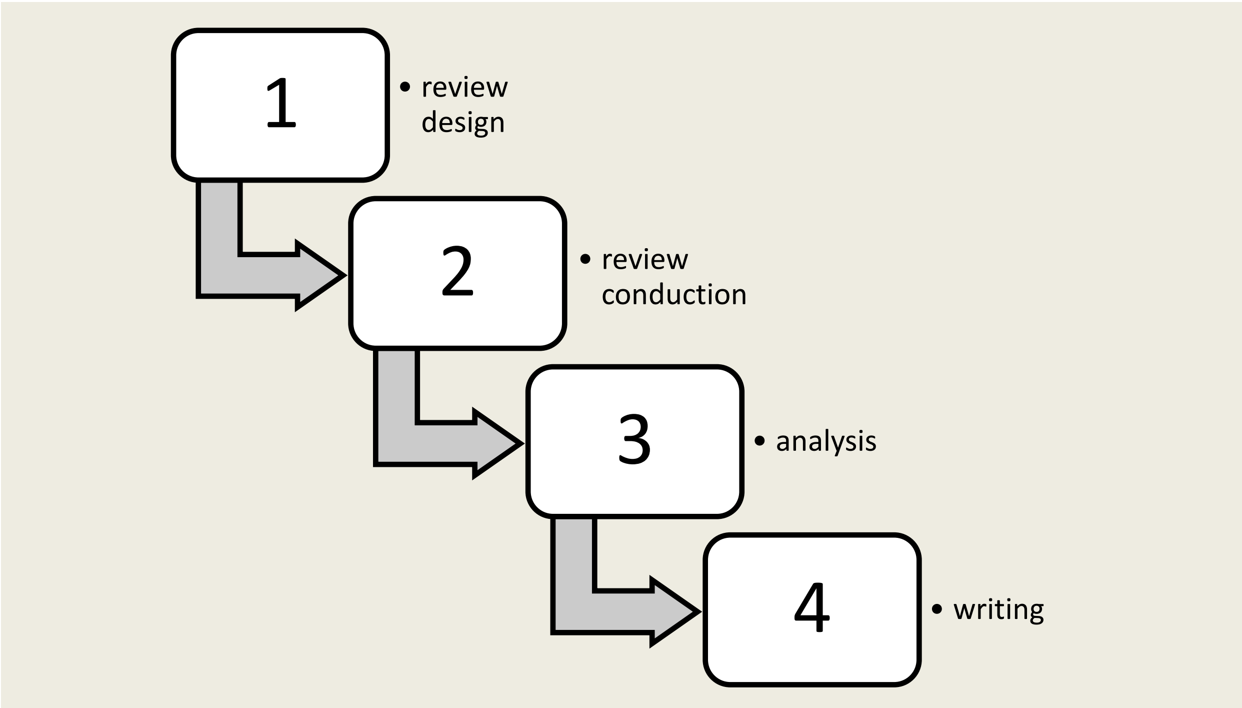

Figure 1: Literature review process (Snyder 2019)

2 THEORETICAL BACKGROUND

This chapter contains all the relevant theory needed in the study. Firstly, different levels of immersiveness in virtual reality are located in the VR continuum; secondly an overview of VR uses in education helps the reader to understand the main focus of this study; thirdly experiential learning is exposed; and fifthly the technology acceptance model, used to investigate the phenomenon of interest, is presented and discussed.

2.1 Immersive VR

Radianti et al. (2020, 3) point out that “immersion apparently has a sociocultural aspect the notion of which changes over time”. Fort this reason, the study needed to take a position and define what is immersive. The final choice was to include only two technologies: head-mounted display (HMD) and Cave Automatic Virtual Environment (CAVE). According to Wu et al. (2015, 45) immersive virtual reality is created when the user is surrounded by virtual technologies and devices such as HMD, haptic touch gloves, CAVE and anything that generates sensorial stimuli, or an interaction between user and virtual environment comparably similar to that in a real environment. Thus, immersive VR fools the user’s senses while in the virtual environment, characterized by its sensory-motoric, cognitive and emotional stimuli (Björk and Holopainen, 2004, 86). Moreover, VR can create an immersive 3D special experience transmitting to the user a sense of belonging to the virtual world, how this feeling is perceived is always subjective and varies from person to person (Benford, et al, 1998, 21). Real time interaction makes such perception credible (Riva 2006, 89), such interactivity is shown in instant feedback to the user for every action undertaken, movement and position. The exchange of information is bidirectional, the user gives physical inputs using VR gear and the system responds with virtual outputs, graphics and sounds. (Martín-Gutiérrez et al, 2017, 102).

A broadly accepted common view of a VR environment is that of where the participant is fully immersed in an entirely synthetic world. This synthetic world can imitate the properties of a real-world environment, both existing and fictional, but also surpass the bounds of physical reality by building a space where physical laws such as gravity, time and material properties do not matter anymore.

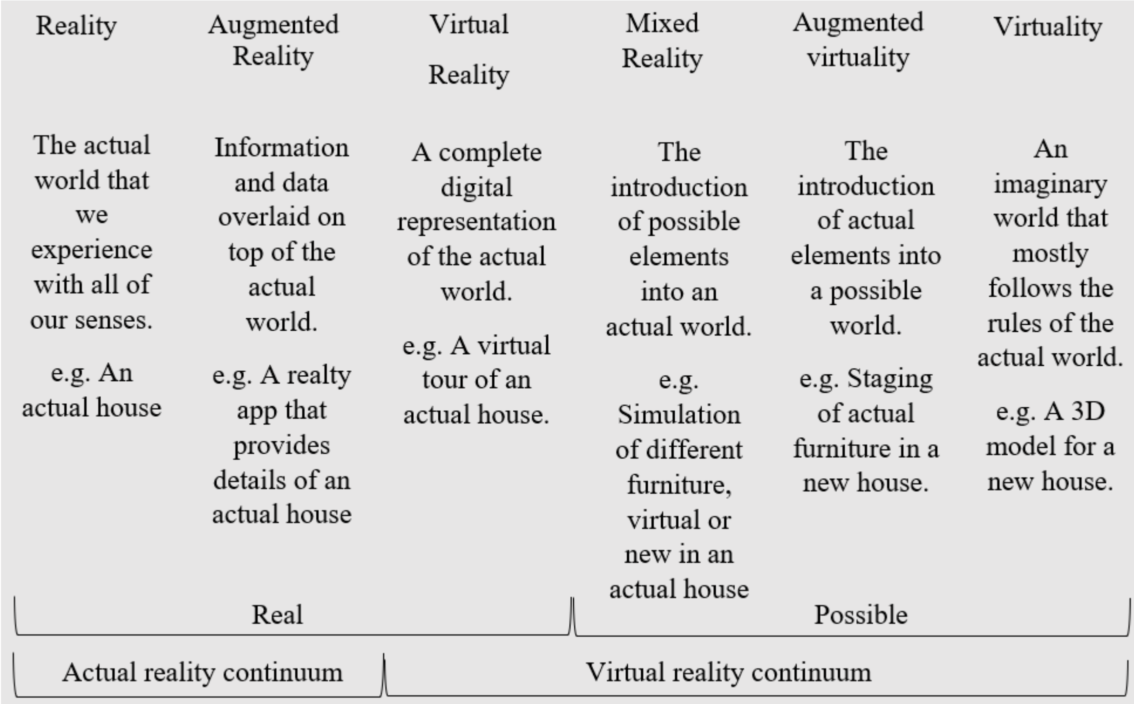

Figure 2: The Virtual Reality Continuum (Farshid et al., 2018)

On the other hand, a clear real-world environment is definitely restrained by these physical laws, placing these two constructs directly opposite of each other (Farshid et al. 2018, 658). However, rather than observing these two concepts just as exact opposites, it is more beneficial to view them as opposite ends of a reality-virtuality continuum (Milgram et al. 1994). To bring some clarity, Farshid et al. (2018) draw the actual reality / virtual reality continuum, identifying six types of reality: (1) reality, (2) augmented reality, (3) virtual reality, (4) mixed reality, (5) augmented virtuality, and (6) virtuality. See figure 2, above.

The first two columns in figure 2 show the actual reality continuum and include reality, as the world we experience first-hand without the use of any device; and augmented reality, the world around us with an additional layer of superimposed information that is computer generated (Farshid et al. 2018). Traditionally, education has always been based on reality, both with the observation of real-world phenomena and objects and from the reading of theories from physical supports such as books, laptops etc. (Milgram et al. 1994). Augmented reality, on the other hand, is the superimposition of computer-generated objects to the real world as we perceive it with our sight. Augmented reality can be accessed with head mounted devices, that add the extra layer of information on top of images of the real world, or through any device (e.g. smartphone, tablet) that shows on a screen the images of the real world combined with the extra layer of information. AR not only enables users to view pre-existing data, but also allows to generate new data, for example by measuring the dimensions of an object thanks to the smartphone camera pointing at it (Milgram et al. 1994). Augmented reality offers extraordinary possibilities for education. For instance, in training, students and trainees can operate complex machines while receiving real time instructions on the screen of a smartphone or through the lenses of a head mounted device. The interactivity of this technology opens a wide range of possibilities (Milgram et al. 1994). From previous studies, it emerges that "the educational value of AR has increased significantly in recent years, and is considered by some to be a likely candidate to emerge as a significant pedagogical tool for improving learning outcomes" (Dede 2009, 59).

Milgram et al. (1994) points out the remarkable number of possibilities offered by these technologies. Nevertheless, it is worth remembering that reality can be assessed following three core properties: (1) a clear distinction between what is computer generated and what is natural and real needs to always be made; (2) immersion needs to be measurable according to the level in which users see the environment and recognize it using their senses; (3) view of the world can come with or without a device, thus affecting directness. (Milgram et al 1994, 349).

Based on the discussion above, this research extents the classic definition of VR "a digitally created environment that you experience in an immersive way, usually through a head-mounted display (HMD)", into broader definition of "any fooling of the senses that is immersive can count for virtual reality" (Kauer interview 24.7.2019). Although many technologies can possibly deliver VR experience, this research focuses only on two: HMD and CAVE. These two are the ones that best meet the requirements for immersiveness set for this study: fooling of the senses, delivering an existential experience through a virtually generated environment.

2.2 Virtual worlds (a non-immersive yet very interesting parenthesis)

Virtual worlds are computer-generated platforms with a high level of interactivity. They reproduce 3D environments, that can resemble either reality or imagination. Users are in most cases given an avatar to represent them. This allows to navigate the virtual world, modify it through action, and communicate with others (Davis et al., 2009; Pannicke and Zarnekow, 2009). The main difference between virtual worlds and videogames, is the lack of predetermined goals to be achieved in the former (Kong and Kwok, 2009). The impression of being part of the virtual world, distinguishes virtual world from other Web 2.0-technologies (wikis, podcasts, blogs).

The golden era of virtual world was around the year 2007. After that, followed a “stage of disillusionment” (Gartner, 2009). Reasons are numerous, unmet expectations, fall out of fashion and lost media visibility. The large diffusion of desktop and laptop computers during the first years of the Twentieth-first Century is one of the factors behind the initial success of Virtual Worlds. Users accessed these platforms through the web-browsers installed on their devices, as they did for any other website. (Stieglitz and Lattemann 2011, 1)

Although initially conceived for entertainment purposes, Virtual Worlds received a remarkable share of attention from higher education institutions. Out of ninety-five articles present in the literature review, forty-three mention Virtual Worlds, 45% of the total. Although by definition Virtual Worlds are non-immersive, the large academic interested in them, convinced us to mention them in this work. I believe that a parallel can be drawn between the widespread of Virtual Worlds in the early 2000’s and a similar diffusion of immersive VR in a possible near future.

Second Life was mentioned in 28 out of 95 articles in the literature. Second Life was launched in 2003 by the company Linden Research Inc. and quickly became one of the most popular and most widely used Virtual World. Second Life still exists, but its popularity has fallen. Second Life is an online community. A new user joins by creating a new account and choosing an avatar, which is the user appearance in the Virtual World. The software runs on a computer screen, it is therefore non-immersive VR. Everything in Second Life is designed using prims, 3D geometric shapes that can be combined to create any kind of object. The user can navigate into the Virtual World, see things from different perspectives, touch objects and interact with other users. All these features make Second Life highly interactive.

Environments in Second Life look like real world, land, water and sky. The whole world is composed by regions, or islands. The company charges 1029 USD plus a 295 USD monthly fee for owning an island. Education institutions are eligible for a 50% discount. (Alvarez et al. 2018, 1)

Second Life is not the only Virtual World available online, in fact, there are over 200 similar platforms. Although Second Life was conceived primarily for entertainment purposes only, it got a lot of attention from many educational institutions. This is due to the high level of interactivity that the platform offers. In Second Life users can move around

and interact between them. This all happens in a way that according to Girvan and Savage (2010, 347) gives a sense of presence, resulting in immersion. The final result is a tool that supports both socialization and collaborative learning. (Knox and Gregory 2012, 2)
3D virtual environments are characterized by unique properties that can be divided in two groups: representational fidelity and user interaction. The user identifies itself as part of the environment thus feeling present in it. A well-designed graphical representation can be very engaging for users in general and students in particular. However, this effect is only temporary and mostly due to the novelty of a Virtual World. It is therefore necessary to combine the element of Virtual Worlds with other technologies, opening to a completely new set of features. In fact, VR gear (HMD and CAVE) could come handy with this. (Herpich et al. 2017, 235)
"SL is not a game; it's the next evolutionary stage of the internet. It merges many qualities of the web, online games, social networking, user-generated content, creativity applications, and telecommunications technologies." (Stewart et al. 2009, 637)
Figures published by Linden Lab back in 2008, show that the Second Life users spent each month a considerable number of hours (females: 41; males: 59). What surprises is the difference between time spent in Second Life and time spent in other Web 2.0 sites such as Facebook or MySpace, only three hours per month (Wood and Hopkins 2008, 1137). However, today interest for Second Life is no longer that high.

It was in fact the high number of users and the vast popularity of it that convinced many educational institutions to consider Second Life as a learning tool. For this purpose open source applications were launched, some of which linked Moodle with Second Life (Stieglitz and Lattemann 2011, 1).

This parenthesis wants to offer a parallel to the study, especially because of the high number of articles covering it in the literature. Nevertheless, as virtual worlds remain a separate domain from VR, this paper deliberately avoids covering them any further.

2.3 VR Hardware and Software

Many solutions exist to enter virtual reality. In this study the author decided to focus on the two types of hardware that enable the highest level of immersion: Cave Automated Virtual Environments (CAVE) and Head Mounted Displays (HMD). CAVE and HMD provide visual and auditory information (output), but an experience would not be complete without the possibility to touch and feel. Direct interaction between user and virtual words is enabled by haptic touch devices (input), these hand-held devices allow users to grab virtual objects and move them around. Ultimately, the combination of inputs and outputs creates a full experience.

2.3.1 Cave Automated Virtual Environments

Cave is a cube-shaped display where the user stands inside. In fact, it is a room, with all the walls, ceiling and floor working as displays or projectors. This VR solution is fully immersive as the user is surrounded by the computer-generated environment showed all around. No external distractions interfere nor alter the experience as the user is completely isolated from the rest of the world. No facial display needed, except for special light-weight glasses, which allow seeing both the virtual and the physical world unobtrusively, thus users enjoy a higher degree of freedom of movements. Moreover, a wide field of view allows a more natural peripheral observation and total gaze control (Molka-Danielsen et al 2015, 184). More than one user at the time can enter the CAVE, making the experience sharable and more interactive. Interaction with the virtual world happens thanks to a hand-held device (Roussos et al. 1997, 63). When a single person enters CAVE, the use of a motion sensor adjusts projected images according to the user's angle of view and movement. As in CAVE the users' body is visible all the time, an important element of realism is present. The original CAVEs were cubed environments with images projected in walls, ceiling and floor. A newer version is the Virtual Dome: a spherical form space with a simplified projection system. CAVE systems are built on-demand, according to customers need so there are no "standard models" as dimensions and features vary. Some of the biggest manufacturers are: Companies Simulation and WOLRDVIZ. (De Carvalho 2019).

2.3.2 Head Mounted Displays

As the name suggests, HMD are gears that mounted on user's head allow entering virtual worlds. Such devices usually consist of a helmet with two small screens, headphones and a motion sensor. An HMD is therefore capable of showing pictures, reproducing sounds and detect changes in user's head orientation and movement. The two screens can show different images to each eye; the result is a 3D stereoscopic visual environment capable of fooling the brain with an illusion of depth. Furthermore, some HMDs feature cameras that capture pictures from the real world and process them with synthetic information in order to create Augmented Reality environments. Many manufacturers have brought to the market their hardware, offering a wide selection of alternatives with a large price range. The cheapest way to experience VR comes from the world leading search engine company, Google. Google Cardboard is a head mounted display, which works with a smartphone. In fact, the Google Cardboard is merely a holder for the smartphone that works as display, headphone, camera and motion sensor. As nowadays most people in the rich world own a smartphone, this solution enables them to add the VR functionality to their handset. Google Carboard costs about ten dollars. Another HMD is Oculus Rift. The company was acquired by the social media giant Facebook in 2015. Their gear retails for 299 dollars and is a reasonable compromise between price and functionality. At the higher end are products like HTC Vive, Samsung Gear VR, Sony Playstation VR and Microsoft HoloLens. (De Carvalho 2019). Figure 4 below shows these models.

2.3.3 Haptic touch devices

The word “haptic” comes from the Greek “haptesthai” and it means, “to touch”. Computer haptics became a new research domain in 1993, when Salisbury and Massie introduced the Personal Haptic Interface Mechanism (PHANTOM). (Civelek, 2014, 566).
Some example of hand-held devices are: Data Gloves, Motion Trackers, and Motion Platforms. Data Gloves collect 3D information about the orientation and position of the hand thanks to motion sensors in the fingers and wrist. Some models vibrate to reproduce the feeling of touch. (De Carvalho 2019). Haptic devices replicate what happens in the real world when by applying forces we touch real objects. This process generates mechanical signals that provide stimuli to the tactile channels and human sensory motor. These stimuli, in addition to the position and motion of hands and arms, are transmitted to the brain as tactile data. A company that specializes in haptic devices is VR Leap.

2.3.4 VR content creation software

In 1996, the cofounder of Windows, Bill Gates said that “content is king”. It was true in the dawn of the internet and it is still true with virtual reality today. Software is as important as hardware for delivering full experiences in immersive VR. The next paragraph offers an overview of the existing platforms for content creation.

Many 3D production technologies are available for creating outstanding contents for VR. Some of the most popular software are: Sketch Up, Blender, 123D Catch, Google

Expeditions, OpenSim and UNITY 3D. The fact that some of these are free of charge open software enables a wider adoption. The popularity of these applications has growth so much in recent years that more and more people started producing content. As a matter of fact, “3D technology is on the brink of making the transition from users as consumers to users as producers” (Dow et al. 2015, 8). VR contents can be either fully computer generated or derive from real world pictures. In this second case, the use of 360 degrees cameras allows to shoot pictured from a certain place, capturing the view from every angle. The pictures collected with 360 cameras can then be optimized for the use with VR gear. 360 cameras can record both static pictures and videos.

2.4 Virtual Reality Technology in Education

Although VR main uses have been in entertainment and gaming, the demand for e-learning has recorded a sensible growth in recent years (Nwaneri, 2017). The technology found use in a large variety of settings, ranging from education and training to therapeutic and healthcare (Dede and Richards, 2017; Ghanbarzadeh and Ghapanchi, 2018). A sharp rise in investments highlight a growing interest for the technology. Business experts anticipate a total market revenue worth of $120 billion in 2020 (Augmented/Virtual Reality Report, 2016). E-learning markets are enjoying a surge in interest too, from $165.21 billion in 2015 to $275 billion in 2022 (Costello 2017, 55).
The perceived usefulness of using Virtual Reality and Augmented Reality in educational activities have been widely investigated during the past decade (Radianti et al. 2020). There have been huge investments to facilitate the access to scale virtual technology and content, mainly on creating virtual content and manufacturing headsets capable of visualizing these contents (Kavanagh et al. 2017, 86). The improved accessibility and affordability of virtual reality technologies will benefit the educational sector greatly as the technology harbors great potential as a teaching tool (Martin-Gutierrez et. al, 2017, 470). Ezziane (2007, 185) acknowledges VR as a tool for educators to assist students to immerse in a learning environment and participate in their own learning in a virtual, technology-based environment. Moore (1995) presents integration of the user in the virtual environment as an essential part of VR: as interface disappears, the user is able to interact with the virtual world directly while Hedberg and Alexander (1994) propose sensory and

psychological immersion as well as active learner engagement as defining educational factors of VR (figure 5, below).

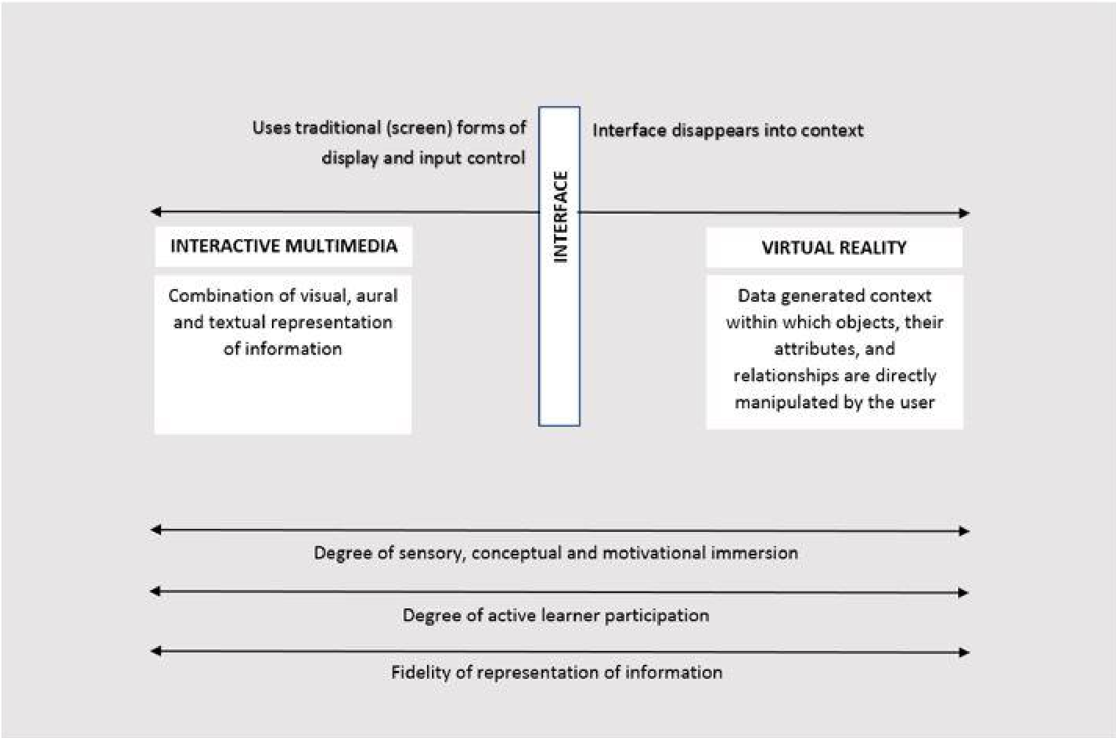

Figure 3: Dimensions for VR in education (Hedberg & Alexander, 1994, 216).

As the figure above shows, when moving from interactive multimedia towards virtual reality, the degree of immersion, fidelity of representation of information and degree of active learner participation changes. Quite similarly, Rosenblum & Cross (1997) name three core aspects to any VR system as Immersion, Interaction and Visual Realism. Sense of immersion can be defined as “the subjective impression that one is participating in a comprehensive, realistic experience” (Dede, 2009, p. 66) Immersion is definitely one of biggest strengths of using VR/AR in education, because it provides a first-person experience (Martin-Gutierrez et al., 2017). Furthermore, Winn & Jackson (1999) argue that the visual nature of VR, as well as the intuitive control and manipulation of virtual objects are the two main factors that enhance learning using VR technology.

In addition to immersion, pedagogy plays an important role when employing virtual reality in educational context. As noted by Martin-Gutierrez et al. (2017, 482) “The limits of using VR/AR in an educational environment is not in technology itself, but in how this technology is used and how students learn. Virtual learning experiences should not be just aimed to gain knowledge, so it is required to design these learning environments from a constructivist approach to obtain full learning benefits". Wu et.al (2015, 44), observe that a great variety of instructional and learning approaches have been included in the design of AR learning environments, including game-based learning, place-based learning, participatory simulations, problem-based learning, role playing, studio-based pedagogy as well as jigsaw method. Focusing on the most important features, Wu et al. (2017, 424) break the instructional approaches into three main groups: approaches emphasizing the roles learners take, approaches emphasizing the interaction between the learner and "physical" location, and approaches emphasizing learning tasks and their design.

2.5 VR in Education

As reported by Martín-Gutiérrez et al. (2017, 478), several scientific studies have observed existing link between the utilization of VR technology and improvement in students' academic performance as well motivation levels (Harris & Reid, 2005; Sotiriou & Bogner, 2008; Di Serio, Ibáñez, & Kloos, 2013; Martín-Gutiérrez & Meneses, 2014; Bacca et al 2014; Holley, Hobbs, & Menown, 2016) Furthermore, Kaufmann, et al, (2005) and Martin-Gutiérrez, et al. (2010) report improvement in students' social and collaborative skills. There's also evidence of improvement in students' psychomotor and cognitive skills (Feng, Duh, & Billinghurst, 2008). These advantages obtained using VR technology bear similarity to the advantages gained using Computer Assisted Instruction (CAI) which success depends on students' empowerment effect, systems' instructional capabilities, usage of newer instructional approaches, and the development of cognitive skills and positive attitudes (Chou, 1998, as cited in Zacharia, 2003). Despite being just imitation of real life, there are features enhancing a real-life experience (Ferry et al., 2004), which enables students to explore new domains, make predictions, design experiments, and interpret results through simulations (Steinberg, 2000).

Similarly to CIA, Virtual Reality has motivating effect and students show positive attitude towards VR and using it in learning (Mikropoulos et. al., 1998). Moreover, according to Martin-Gutierrez et al. (2017, 478) Virtual Reality grabs students' attention and promotes engagement – using Virtual Reality is both interesting and challenging and gives an opportunity to interact, create, and manipulate objects in a virtual environment in visual and precise way impossible to show in a real environment. Furthermore, virtual technologies enable students to be exposed to abstract concepts with models they can interact with, which in turn facilitates exposing students to knowledge using a constructivist approach (Winn, 1993), which in turn can solve learning difficulties observed in the past research (Wu et al., 2013, 44): For instance, students' reportedly have difficulties with visualizing unobservable phenomena (Kerwalla et al., 2006). As virtual reality technology allows students to observe or manipulate virtual objects and invisible phenomena, this learning experience can enhance students' thinking skills and conceptual understandings about invisible phenomena (Liu et al., 2009) as well as correct their misconceptions (Sotiriou & Bogner, 2008).

As long as the students are the main actors when experimenting and practicing with virtual technology, this approach promotes student-centered learning experience (Winn, 2002). As such, virtual technologies promote students to take active role in learning as VR/AR technology encourages decision-making when interacting with virtual environments. This permits autonomous exploration, helps to understand complex concepts, promotes new experiences, as well as facilitates learning by doing (Martin-Gutierrez et al., 2017,479). A VR system can provide real-time feedback and give verbal and nonverbal cues to foster students' sense of immediacy. Furthermore, the real time interaction enables visualizing results instantly so that learners can make decisions, based on these results, to reach their learning goals as well as to improve their learning performance and cognitive skills (Kotranza et al., 2009). To conclude, such advantages boost student's engagement through immersiveness and experiential learning. Distractions are reduced to the minimum or eliminated entirely, moreover students' feedback is often positive as these technologies help them to better reach their own learning goals. (Martin-Gutierrez et al., 2017, 479).

3 EXPERIENTIAL LEARNING

Literature distinguishes between several learning paradigms: behaviorism, cognitivism, constructivism, connectivism and experiential learning (Radianti et al. 2020, 3) From each learning paradigm follow various theories about educational goals and outcomes such as motivation, performance, knowledge transfer, and emotions. This study chose to utilize the theory that "perhaps is the most famous perspective on adult experiential learning" (Malinen, 2000, 18). Kolb's experiential learning theory. This chapter presents it. Firstly, with a closer look at what is knowledge, secondly with the definition of what constitutes an experience and lasty with the experiential learning cycle, which is the main contribution of Kolb's research.

3.1 Knowledge

After fifteen years of study, Kolb theories were presented in his book "Experiential learning, experience as the source of learning" where he defines experiential learning as "a program profoundly re-creating our personal lives and social systems" (1984, 18). Kolb's studies remain a "guiding philosophy and conceptual rationale as well as a practical educational tool for lifelong learning" (Malinen 2000, 19). What makes Kolb's contribution remarkable is the profound impact it left on both management training and professional development research (Malinen 2000, 19).

However, for the purpose of this study, before diving deeply into Kolb's ideas, it is important to understand what knowledge is. Then, a definition of what constitutes an experience would clarify the domain of this study. The final goal is to discover how experiences contribute to the building of knowledge, in what Kolb called experiential learning. One key difference between Kolb and many others who studied experiential learning (Knowles, Mezirow, Revans, Schön), was the former interest in epistemological problems as well as psychological questions surrounding adult experiential learning. In fact, he claims that "hence, to understand knowledge, we must understand the psychology of the learning process, and to understand learning, we must understand epistemology – the origins, nature, methods and limits of knowledge" (1984, 37).

Kolb identifies two distinct types of knowledge: social and personal. From this first distinction he would then come to the conclusion that "learning is the process of creating knowledge that is the result of the transaction between social knowledge and personal knowledge" (1984, 35). But first, a look at these two types of knowledge and understand what they are.

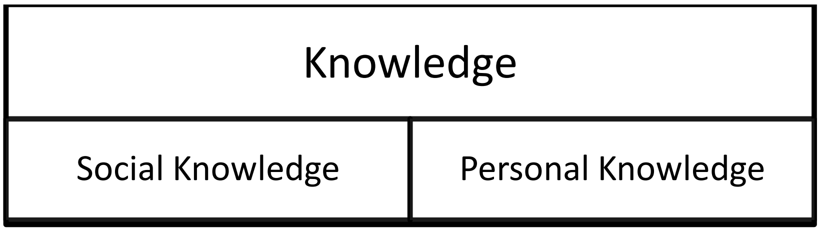

Figure 4: The Nature and Qualities of Knowledge (Kolb 1984)

As the name suggests, social knowledge is everything inherited from previous human societies. This type of knowledge includes all those objects accumulated during previous cultural experiences occurred to people who lived before us. This vast patrimony includes everything that has been transmitted from generation to generation and among other things includes words, symbols, and images. The key to access this knowledge is comprehension as it remains detached from singular personal experience. Nevertheless, social knowledge shapes the way people see the world and guides them towards decision making. And ultimately, this affects the way experiences are perceived. Social knowledge is always learned. As societies evolve, so does social knowledge, from this follow that valid social knowledge is created at all times. (Malinen 2000, 30)

At the other end of the spectrum finds its place personal knowledge. This is the totality of subjective life experiences accumulated during one person's life. Personal knowledge combines both direct apprehensions and acquired comprehensions. Personal knowledge explains experiences and thus guides actions. Personal knowledge develops from the influence social knowledge has on the way an individual interprets, acquires, and stores any new knowledge (social knowledge). To conclude, social knowledge can be compared to a filter through which information passes before being stored on the tank, which is personal knowledge. (Malinen 2000, 30)

3.2 Knowledge by apprehension

The Merriam Webster online dictionary defines apprehension as "the act or power of perceiving or comprehending something". Apprehension is another pillar of Kolb's theory. With apprehension, new information is registered by the brain. Such process is strictly personal and therefore inaccessible to others. This supports and strengthens the validity of personal knowledge as every individual develops a personal and unique way of collecting information. (Kolb 1984, 56) Apprehension is perceived as an experience that happens here and now. It is a dynamic form of perceiving things that are tangible, concrete and immediate. Apprehension generates the logics that enable us to understand why event B follows event A. For this reason, apprehension can be considered as "the ultimate source of the validity of comprehension in fact and value" (Malinen 2000, 39). From here, Kolb develops his well-known experiential learning circle. A key point to understand his theorem emerges from the conviction that "the simple perception of experience is not sufficient for learning; something must be done with it" (Kolb 1984, 42). Learning and developing knowledge through experience remains the ultimate goal. But before closing the circle, first a look at what constitutes experience.

3.3 The experience of learning

At the beginning of the Twentieth century educational psychologists Dewey and Lewin paved the way for experience as a form and source of education and learning. Their interest was fueled by the large potential they saw in this new approach. Among the numerous benefits, the most outstanding were: (1) a far deeper knowledge (Chickering & Gamson, 1987), (2) a superior level of engagement (Hanson & Moser, 2003; Schott & Sutherland, 2009), (3) the development of a smarter and more efficient decision making (Cantor, 1997), and (4) lifelong learning (Grabinger & Dunlap, 1995). It is interesting to notice that the discussion on these benefits still remains open nowadays. Hence, the emphasis on building knowledge from direct experience, enables the understanding and memorization of new knowledge on a deeper level (Alrehaili 2018, 52). Primary education started using experiential learning already on the early days. But later, tertiary education too started to appreciate and grow a bigger and bigger interest towards the benefits that learning through experience delivers to adult students. And this is the main focus of this study. Kolb (1984) points out the fact that several and diverse disciplines applied experiential learning. These include: Computer Science, Accounting, Law, Management, Education, Medicine, Psychology and Nursing. Experiential learning finds its natural collocation in learning environments such as site visits and fieldtrips, internships, laboratory activities and role play (Cantor, 1997; Healey & Jenkins, 2000; Wurdinger & Carlson, 2009). Again, such uses pinpoint the large potential experiential learning has in tertiary and professional education as well as in any other kind of education. Today, technology offers more powerful and efficient tools to unleash the full potential of experiential learning and open a completely new world of possibilities. Immersive virtual reality, with its capability of reproducing virtually any environment and experience is certainly a very interesting tool for experiential learning. Moreover, the high level of responsiveness, together with visual and auditory stimuli make the whole experience more real. (Schott & Marshall 2018)

3.4 Experiential Learning in Immersive Virtual Reality

As it already emerged from the previous paragraph, immersive virtual reality is a great tool of experiential learning. Virtual reality has a great potential to deliver authentic experiences. Winn (1993) stresses the full compatibility of immersive VR with the pillars of constructivist learning theory. Furthermore, he adds that constructivist theory contains a solid theoretical foundation for learning in virtual worlds. In fact, the two factors behind the compatibility of VR with constructivism are the personal perception users experience in VR experience and the deep immersiveness. Zhang and Liu (2011) favor the idea that the human brain constantly collects knowledge from the environment and its surroundings. Both observation and interaction enable this process. (Maghool 2018, 255) In spite of the very high potential and the very promising possibilities, the use of VR remains limited due to the high costs of the needed gear. This remains the major obstacle for the larger adoption of such technology.

3.5 The Experiential Learning Cycle

Kolb (1984) believes in the power of experience as an effective source of learning. “Learning is a continuous process grounded in experience. Knowledge is continuously derived from and tested out in the experiences of the learner” (1984, 27). Discovery and experience are the two factors guiding a person towards a better and deeper learning. This is the experiential learning cycle in a nutshell.

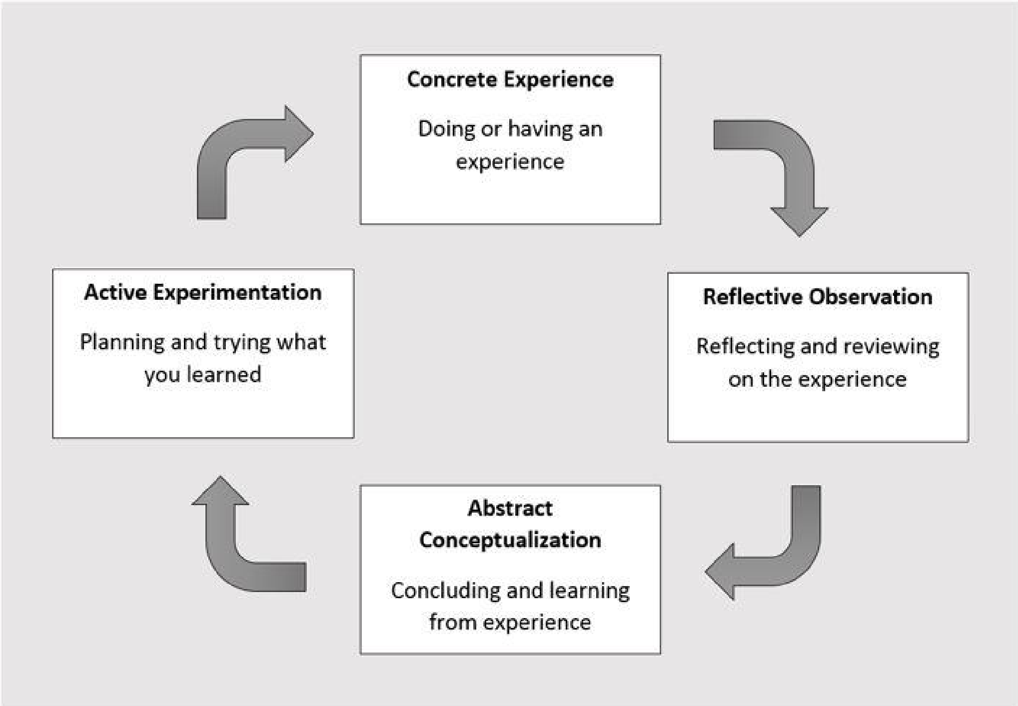

Figure 5: Experiential Learning Cycle (Kolb, 1984)

The picture above shows the four stages of the experiential leaning cycle. These four stages follow always the same exact order and keep repeating themselves over and over again. The concrete experience opens the experiential learning circle and is thus the very first step. Here, something is experienced and felt. This can happen anytime and anywhere as long as the experience is strong and significant enough to stimulate the senses and thus send stimuli to the brain. After the concrete experience, reflective observation follows as the second step. Once the initial experience stimulates the learner's interest and curiosity, it is worth spending some time thinking about what previously happened. Doing so, the learner integrates and absorbs some initial knowledge, which will be refined during the following steps. The third step is abstract conceptualization. A continuation of step number two, but on a deeper level. Once understood the experience, a learner needs to explain it. The fourth and last step in the circle, emphasizes the importance and benefits of being an active learner. This last point gives continuity to the circle, creating a loop, where experiences follow one another. And knowledge keeps piling up. Time is totally absent from this model. This is due to the fact that the circle is personal. Every individual build experiences differently. Time is therefore not a good indicator of neither results nor quality of learning (Baylenson 2019, 45). A great advantage of the use of VR in experiential learning is the possibility to unlimitedly repeat any experience at no costs. Users can go through the same experience as many times as they deem necessary.

3.6 Experiential Learning in Virtual Worlds

There is a core problem with non-immersive software-based learning platforms (e.g. Moodle), they lack the ability to engage users as virtual worlds do. Experiential learning is based on two core pillars: action taken by learner, and the following reflection on it. The union and combination of these two pillars, sustains long-lasting knowledge. In fact, experiential learning provides the tools to link action and cognition. Thus, it is the internalization of our own observed interactions that results in experience and ultimately knowledge. (Beard and Wilson 2002)

Experiences are the engine of Kolb's learning cycle, they need to be concrete, hence perceived by the learner as real and authentic. What follows is always a reflection on what has been observed during the experience, which is then conceptualized with the help of rules and theories. The use of experiments reactivates experiences, makes them more understandable. Finally, the cycle, as a loop, strengthens the assimilation of new concepts, which sum up to enlarge knowledge, filling the gaps with what was previously known. (Kolb 1984)

Jarmon et al. (2009) claim that the learning cycle can be supported by the implementation of 3D virtual learning environments. Virtual world with their high level of visual and auditory stimuli, combined with enhanced interactivity are definitely a fantastic tool to replicate endlessly experiential learning activities.

Stieglitz and Lattemann (2011) draw a framework helpful to visualize the various levels of interaction and immersion and their impact on learning. The framework, a two-by-two matrix, is shown in figure 7 below.

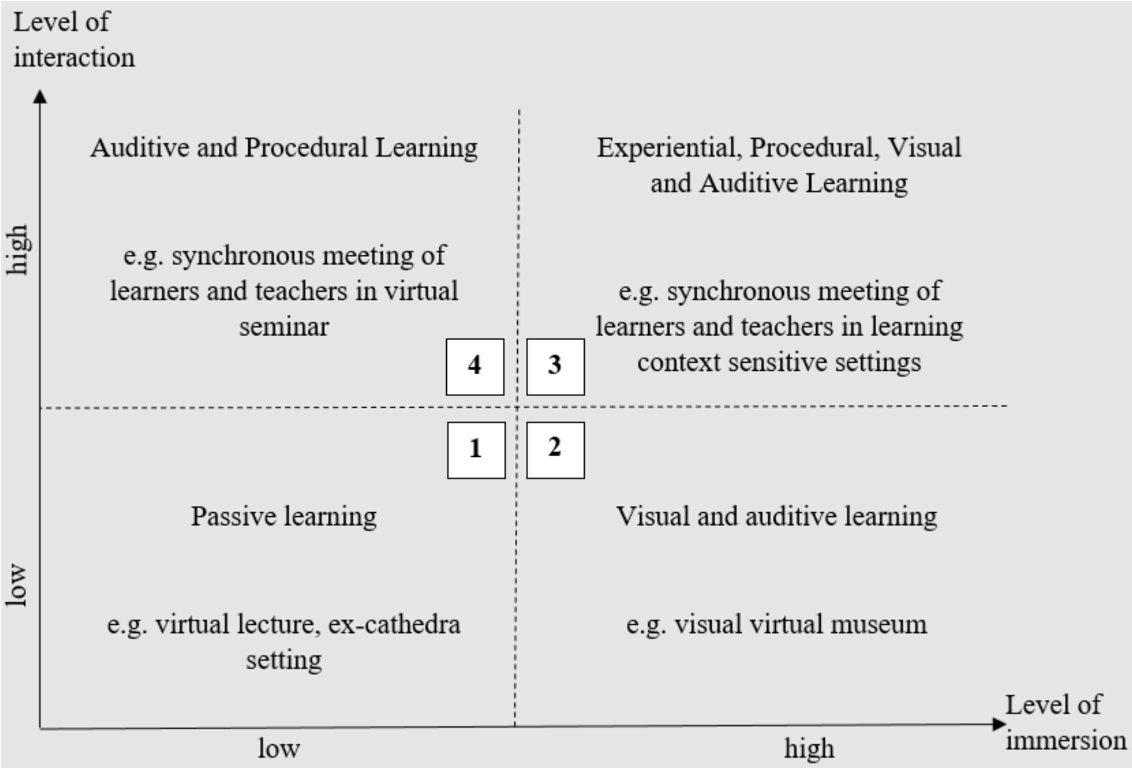

Figure 6: Levels of immersion and interaction. Stieglitz and Lattemann (2011)

A low level of interaction and immersion, quadrant 1, is typical of more traditional ways of teaching such a lecturing in a classroom, where learners engagement remains low, the outcome is a mere passive learning. When only one value is high, either immersion or interaction, like in quadrants 2 and 3, the learning is still incomplete as it lacks some elements. Only quadrant 4, where both values are high, represents the ideal setting for experiential learning. (Stieglitz and Lattemann 2011,2-3).

An important thing to remember, is the design of immersive VR learning environments. The only fact of learning in VR is insufficient for having experiential learning. The virtual world needs to be designed in a way that allows both a high level of immersion, and a high level of interaction. If either one is missing, the experience would be incomplete and therefore all the benefits of experiential learning jeopardized. (Kauer interview 2019)

4 TECHNOLOGY ACCEPTANCE MODEL (TAM)

In his study, Davis (1989) investigated the reasons why users are sometimes reluctant to adopt new technology although it might improve their performance at work. His work focused on white collar workers in a time, the Eighties, when personal computers (PCs) were entering offices and workplaces, especially in the rich world. But the theory that he developed can be utilized in other sectors and times too (Manis and Choi, 2019). After reviewing the relevant previous studies: expectancy theory, self-efficacy theory, behavioral decision theory, diffusion of innovations, marketing, and human-computer interaction, Davis concluded that the two most significant factors behind technology acceptance are: (1) perceived usefulness and (2) perceived ease of use. Based on these two, he elaborated his Technology Acceptance Model (TAM). Ultimately, TAM enables a more comprehensive understanding of user's adoption patterns, therefore benefiting both vendors and information system managers who can use this information for understanding final users' attitudes towards new hardware and software (Davis 1989, 4).

According to Davis' study, managers thought that these new machines (PCs) would improve productivity, empowering employees to complete more tasks and better in a shorter period of time. Therefore, investing in these machines would have boosted a company's profitability in the long run. Aware of a massive business opportunity, retailers were jumping to this new space, offering the newest computers with tempting prices. At the other end of the spectrum, were employees, the final users of these machines, the ones who needed to adapt to a new way of doing work. This scenario is rather similar to that of education. Where instead of company managers, there is the university administration and instead of office workers, the final users of technology are professors and students. Finally, companies who sell IT solutions use a similar approach, trying to reach for those with the money: firm managers or university administrators (Kauer interview 24.7.2019).

When interviewing Kauer, we asked who the main stakeholders are, when it comes to the adoption of a new technology in University. He mentioned his experience at Stanford, where a vice provost office is in charge for the purchasing of educational equipment. Salespeople from vendors reach out to the provost office and offer their hardware and software. At this point, the vice provost asks teachers whether they are interested in using the new technology. According to Kauer, professors in major universities in the US have a lot of freedom, thus they can accept or refuse to introduce anything to their courses. If teachers are interested and the school can afford the machines, these will eventually be bought and utilized in classes. It is at this point that the real value of these tools is revealed. Both professors and students need to like the new devices and find them useful and efficient. The easiest measure of accountability is how much students learn (perceived usefulness) and how easy and convenient these devices are to work with (perceived ease of use). Both can be assessed and measured according to users' impressions. But again, one user's impression is always a subjective opinion and never an objective reality, however, with a large enough sample of users, relevant patterns emerge, and these allow educated decisions to be made.

4.1 Perceived usefulness

"perceived usefulness is typically found to be the primary determinant of one's use of a technology" (Manis and Choi 2019, 510).

Perceived usefulness (PU) is "the degree to which a person believes that using a particular system would enhance his or her job performance. (Davis 1989, 320)". Manis and Choi (2019) define perceived usefulness as "the degree to which a person believes using a particular system would be beneficial and advantageous (505). The Oxford online dictionary defines the word "useful" as something "that can help you to do or achieve what you want". Thus, people need to be convinced that using a certain tool, software or machine will enable them to reach their goals. It is therefore pivotal for a system high in perceived usefulness, to be capable of delivering a positive use-performance relationship in a way that users believe. It is important to notice that usefulness is "perceived", so it is subjective to the person experiencing it and not an objective truth. Moreover, "user reactions to computers are complex and multifaceted" (Davis 1989, 335). This means that no measurement can ever be generalized, but it is rather the opinion of one or more human beings. To support this claim, several studies have proven the presence of sensible discrepancies between perceived and actual performance (Cats-Baril and Huber, 1987; Dickson, et al., 1986; Gallupe and DeSanctis, 1988; Mclntyre, 1982; Sharda, et al., 1988). Therefore, even an objectively improved performance, if unperceived by users will lead to the rejection of a new tool (Alavi and Henderson, 1981). On the other hand, people sometimes overrate the gains in performance from a new system, thus adopting dysfunctional systems.

When it comes to the adoption of a completely new tool, communicating its value, potential and capabilities is the key task for vendors, who ultimately need to convince users to switch from the older way of doing things, to a new one. Moreover, vendors need to convince users why their solution is better than any other possible alternative or substitute. Another important distinction is that between intrinsic motivation and usefulness. Intrinsic motivation marks the reinforcement and enjoyment which relate to the mere performing of a behavior, regardless of any external outcomes that may come as a result of such behavior. On the other hand, usefulness regards performance as the consequence of use (Davis 1989, 334)

4.2 Perceived ease of use

Perceived ease of use (PEOU) refers to "the degree to which a person believes that using a particular system would be free of effort." (Davis 1989, 320). The Oxford online dictionary defines the noun “ease” as “lack of difficulty”. As effort is a limited resource, users are more likely to welcome anything that would diminish the amount of struggle needed to complete a task. Therefore, an application perceived as intuitive and hassle-free, or more simply, easy-to-use will with greater likeability be accepted by new users, who will start using it. Hence, people enjoy using easy and intuitive tools. Ease of use is both mental and physical. In the case of virtual reality, the fact that some people experience VR sickness can lead to a refuse to adopt the technology.

Ease of use and ease of learning are strongly related. Studies of how people learn new systems suggest that people are motivated to begin performing actual work directly and try to "learn by doing" as opposed to going through user manuals or online tutorials. Therefore, learning and using are not separate, disjoint activities (Davis 1989, 325).

A great effort required to start using a new tool represents a strong barrier to the acceptance of such a tool, or otherwise its rejection. A new technology enjoys a high perception of ease of use when the benefits of usage outweigh the effort of using the application (Davis, 1989). On top of the clear direct benefits ease of use brings to the final user, it also affects productivity. In fact, a more intuitive system demands a reduced effort to operate, hence, the economized effort and time can be allocated to other activities with a sensible increase in job performance (Davis 1989, 334).

One of the main findings from Davis study is that usefulness had a greater correlation with usage behavior than ease of use. In fact, users are driven to adopt a new tool, firstly because of the enhanced functions it performs for them, and secondly for how easy or hard it is to utilize such tool. For example, users often see some increased difficulty of use in a new system as a trade-off to critically needed functionality and are therefore willing to cope with the new challenge. On the contrary, although difficulty of use might discourage the adoption of an otherwise useful system, no amount of ease of use can possibly compensate for an undeforming system. This aspect has important implications for those designing new systems, technology or tools (Davis 1989, 333-334).

The table below, illustrates the technology acceptance model. On the left hand, PEOU and PU define first the attitude towards using a new system. PU and attitude then determine the behavioral intention to use, which ultimately defines the actual use. It is interesting to notice that sometimes the actual use of a technology might be different from what originally though by the developers. For example, the world most popular carbonated drink, Coca-Cola, was originally meant to be a cure for morphine addition. Chainsaws where originally meant to be used in cutting bones during operations. The examples are numerous.

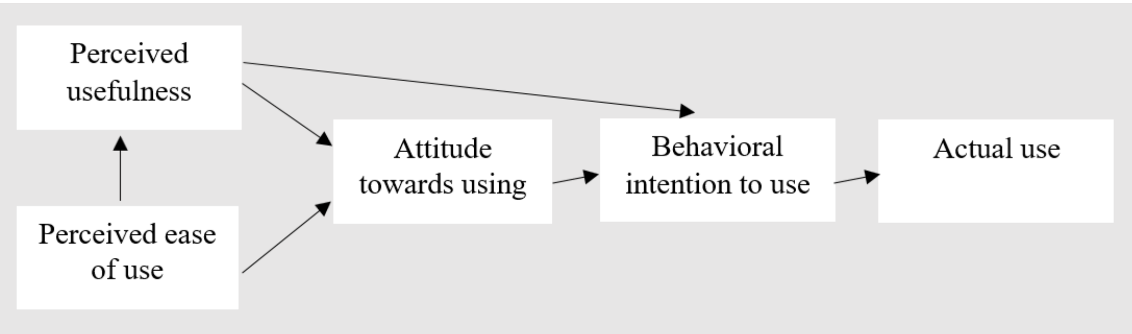

Figure 7: Original Technology Acceptance Model (Davis, 1986).

Manis and Choi (2019) reviewed the TAM and readapted it to VR hardware. The outcome is an improved model with a new variable, perceived enjoyment, as previously done by Davis, Bagozzi, and Warshaw (1992), who defined it as “the degree to which the activity of using technology is perceived to be enjoyable in its own right apart from any performance consequences that may be anticipated” (Manis and Choi 2019, 505). Other scholars too have established enjoyment as a major factor motivating the use of new technology (Bruner & Kumar, 2005; Davis et al., 1992; Lee, Cheung, & Chen, 2005). Kauer (interview 2019) also mentioned that although many teachers would never admit it, they want to look good in front of their students, hence offering cool activities. Perceived enjoyment belongs to the TAM. Another addition Manis and Choi (2019) bring to the original TAM is more specific to the acceptance of virtual reality hardware: the four fundamental antecedents: (1) age, (2) curiosity, (3) past use, and (4) price willing to pay. This study elucidates the key factors marketers, developers, and firms need to consider in order to overcome the challenges posed by the emergence of virtual reality and obtain a positive return of investment (ROI).

5 RESEARCH DESIGN

This chapter illustrates the process and all the steps taken during the conduction of this research. Methodology, data collection, analysis and decisions taken during the work are exposed and discussed in order to provide clarity, transparency and trustworthiness.

5.1 Methodology

The purpose of the study is to analyze and understand why VR and immersive technologies are viable tools to deliver experiential learning. This main research question is further divided to into two sub questions:

- What is the perceived usefulness of immersive technologies in experiential learning?
- What is the perceived ease of use of immersive technologies in experiential learning?

In order to answer these research questions several analysis frameworks were developed to conduct a systematic review of existing literature. These frameworks guided the article search and selection, coding and data analysis for this study. The research design of this study is discussed in this chapter. Research approach, data collection, analysis and decisions taken during the work are exposed and discussed with the intent of providing clarity and transparency. Finally, trustworthiness principles used to provide a solid base to the study are presented and explained.

5.2 Research Approach

There are three types of research approaches that an empirical research typically employs: qualitative, quantitative, and mixed method approach (Creswell 2003, 18-19). The choice of the research method should be based on the research questions and certain types of research problems call for specific approaches. In a case where a concept or phenomenon needs to be fully explored and understood because little research has been conducted on it, or the researcher does not know all essential variables to examine, qualitative approach is appropriate (Creswell 2003, 20). Furthermore, this type of approach might be required if the topic is new, the theory is inadequate subject has never been addressed with a certain sample or group of people, and existing theories do not apply with the particular sample or group under study (Morse 1991, 120). This study is focused on understanding how users perceive immersive VR and what affects their willingness or unwillingness to accept this new technology, as well what benefits VR can bring in experiential learning. While several studies and even systematic reviews have been conducted on VR, none of these have focused on the subjective (user perceptions) and objective (benefits) factors driving VR adoption in experiential learning. In brief, the aim is to build knowledge and understand underlying factors. As such, qualitative approach is adopted. The qualitative method is well-suited for this kind of knowledge-building as it is exploratory and flexible towards the output of the research (Eriksson& Kovalainen, 2008, 6). Moreover, it allows us to understand the phenomenon within specified context and provides an opportunity to gain new information about the phenomenon in that specified context (Eriksson & Kovalainen 2008, 5).

There are numerous methods to conduct a qualitative study (Eriksson & Kovalainen 2008, 5). For this research, author decided to conduct a systematic literature review. This method is further discussed in the following paragraph. However, while the main focus of the research is indeed qualitative, this research also provides some quantitative data as a result of the analysis, namely how many times the codes, based on research questions, appeared in the articles. Notably, this quantitative data does not answer the research question, but it does help the researchers evaluating the quality of the articles and article selection process by showing how much relevant information was found from the analysed articles.

5.3 Systematic Literature Review

Systematic review as a research method emerged within the medical field in UK as a result of need for better, evidence-based research, and has since extended across many sciences and fields (Denyer and Neely 2004; Tranfield et al. 2003). In its simplest form, a systematic review can be explained as a process of identifying and critically appraising relevant research as well as for collecting and analysing data from identified research (Liberati et al., 2009). The aim of this kind of a research is to assemble as many relevant evidence-based studies as possible, provided that the studies are relevant to the conducted research (Thorpe et al. 2005, 258).

While systematic review remains marginal in business research, its use has been steadily increasing (see e.g., Snyder, Witell, Gustafsson, Fombelle, & Kristensson, 2016; Verlegh & Steenkamp, 1999; Witell, Snyder, Gustafsson, Fombelle, & Kristensson, 2016). Differing from traditional narrative reviews, systematic literature review adopts a systematic, replicable, scientific and transparent research process in order to reduce bias by conducting extensive literature search of published and unpublished studies, and by carefully examining the audit trail of the researcher's decisions, practices and conclusions (Cook, Mulrow & Haynes 1997, 377). By minimizing bias by such explicit and systematic review, systematic literature review can provide reliable findings from which conclusions can be drawn and decisions made (Moher et al. 2009, 3).

In addition to reducing bias, systematic literature review as a research method has several other benefits, justifying the choice of method for this study. First, well-conducted review creates a firm foundation for increasing knowledge and promoting theory development (Webster & Watson 2002, 3). Second, by integrating findings and perspectives from several empirical studies, literature review can address research questions with capability no other single research has (Snyder 2019, 333). Third, the included studies can be systemically compared to establish generalizability of findings and consistency of results, namely, to determine whether the studied effect is constant across studies (Davies & Crombie, 2001; Davies et al. 2014, 1). Finally, systematic review has the power to reveal what future studies are required to demonstrate the effect, illustrating points for further research (Davies et al. 2014, 1). In addition to these benefits, systematic literature has been utilized in the previous research to look into the state of virtual reality (see e.g. Radianti et al. 2020; Wang et al. 2018; Kavanagh et al. 2018; Chuah 2018). Notably, these studies have different focus but nonetheless demonstrate how systematic literature review can be used to conduct this research. A systematic literature review is a way to conduct research by methodically analysing existing publications, with a clear and well-defined objective in mind. The articles analysed, need to meet those criteria that were defined before starting the review. Articles need therefore to be deemed eligible. Once the analysis is completed, its validity shall be proved in accordance to predetermined validity measures. This also helps eliminating biases of any kind. Finally, the findings are synthetized and presented in an exhaustive and comprehensible way.

To summarize, keys to systematic reviews are bias minimization, plus transparent and reproducible methods. Figure 10 (below) summarizes the overall steps used in this research and frameworks used in each phase are examined in subsequential chapters to provide the required transparency.

Figure 8: Research process for systematic literature review

After defining the final research questions, inclusion and exclusion criteria were used to set the boundaries for the systematic review of articles. However, before deciding the final inclusion and exclusion criteria, several scoping searches were undertaken to determine the appropriate criteria. Through trial and error, the final criteria were set for the articles. After this selection process, the chosen articles were first coded using Nvivo and then analyzed. Finally, critical appraisal was conducted to judge the validity and quality of the research.

According to Snyder (2019, 334) three are the possible approaches for a literature review: (1) systematic, (2) semi-systematic and (3) integrative. Based on the nature of our research, the semi-systematic approach offered the most suitable alternative. Thus, that is what we used. In fact, the semi-systematic approach is suitable for the study of those topics that "have been conceptualized differently and studied by various groups of researchers within diverse disciplines" (Snyder 2019, 335). Immersive virtual reality has been studied and conceptualized in many ways by various groups of researchers from numerous disciplines. The articles in this literature contain examples that range from nursing to law, and from business to teaching chemistry to children, just to name a few. The different nature of these disciplines has certainly affected the process of conceptualization during their experimentations with VR.

A semi-systematic approach comes handy when "review every single article that could be relevant to the topic is simply not possible" (Snyder 2019, 335). A collection of every article ever written on the use of immersive VR for experiential learning would be unfeasible, due to the enormous amount of existing publications. Thus, the choice to extract data from three different popular academic databases (Web of Science, Scopus and IEEE), using simple but yet precise criteria offered a viable solution to gain a deep understanding on the current state of research, while maintaining the amount of data under analysis on a manageable level.

A semi-systematic approach does more than merely overviewing a topic. In fact, it "looks at how research within a selected field has progressed over time" (Snyder 2019, 335). This method enabled us to collect data from a long period of time, over twenty years, ranging from 1997 to 2019. Therefore, we were able to observe how research developed during over two decades. Moreover, such diverse yet coherent dataset enabled us to pinpoint some research traditions that were unknown to me before I started the work. One remarkable example is Second Life, an avatar based social media, that has been largely used in educational settings. Although this web-browser based technology is non-immersive, hence unrelated to the main object of the research, some of the information contained in some of the articles in the literature gave us useful insights. In the end, a short parenthesis on Second Life was introduced to this thesis because it helps to draw an interesting parallel between the acceptance of virtual worlds in academic settings. Due to the complexity of this research, the long period of time covered and the numerous fields of application of VR, the aim is to maintain the highest possible level of transparency. We try to accomplish this by illustrating every single step in a clear, understandable and intuitive way so that the reader can assess the reasonability of the arguments. The content analysis tries to identify, analyze, and report patterns in the form of themes within the selected texts in a qualitative way. When analyzing the content of this literature, we paid special attention to anything related on users' attitudes towards immersive virtual reality. In fact, anything that could even partly answer to either one of the subquestions was coded. Perceived usefulness and perceived ease of use are exposed in the next session.

The ultimate goal of a semi-systematic review should be to contribute to "detecting themes, theoretical perspectives, or common issues within a specific research discipline or methodology or for identifying components of a theoretical concept" (Snyder 2019, 335). In the very case of the present manuscript, the main contribution is a synthesis of the current state of knowledge on users' acceptance of immersive virtual reality for experiential learning, with the historical overview on a time period long over two decades.

5.4 Research steps

The very first step in this literature review is data sourcing (top box in figure below). After consulting the personnel from the university library, we concluded that academic databases offer the most suitable tools for collecting relevant, reliable and up to date information. Thus, for the data collection, we opted for the three most popular databases in respect to business and computer sciences: Scopus, Web of Science (WoS) and IEEE. Library staff warned us that each database functions differently. In order to avoid biases in the data collection process, we decided to limit to the minimum the use of the extra features present in each database, thus entering the exact same search query everywhere, and accessing to the unfiltered retrieved results. After trying with many possible keywords, a process that took several hours, we finally got a viable search query: "immersive virtual reality experiential learning". By entering the search query in each and every one of the three databases, and after eliminating the duplicate titles, we collected a total of 95 unique articles.

Once data is collected, screening follows (second box in figure below): inclusion and exclusion criteria setting. This study focuses on immersive virtual reality, but as Radianti et al. (2020, 3) point out, "immersion apparently has a sociocultural aspect the notion of which changes over time". We thus decided to accept as immersive technologies only head-mounted display (HMD) and Cave Automatic Virtual Environment (CAVE). Hence technology is the first inclusion criteria, according to which we excluded all articles that describe different technologies, such for example the web browser based Second Life and other Virtual Worlds. Moreover, the study investigates the utilization of immersive VR for experiential learning. We thus included only those articles that explicitly mention experiential learning. And this is the second inclusion criteria. Finally, out of the initial ninety-five (95) articles collected, only thirty-six (36) met the criteria and were thus included while the remaining fifty-nine (59) were excluded.

The following step (third box in figure below) is coding. As this study tries to answer to three (3) sub-questions and eventually to the main research question, the coding focuses on everything that can possibly relate to the sub-questions: perceived ease of use (PEOU), perceived usefulness (PU) and benefits. The first two, PEOU and PU are in accordance to the technology acceptance model (TAM), illustrated in the theoretical chapter in this manuscript. There are many ways to code a literature review, from an Excel spreadsheet to a Word document, but we decided to use a more powerful tool, specifically designed for this purpose: the NVivo software. This package enabled us to easily access all the 36 articles from the same file and instantly compare and search for references from different authors.

The final step in this review (bottom square in figure below) is the analysis of coded data. Again, NVivo came very handy for this job, as all the relevant information is included in one single document. By comparing and analyzing what different authors wrote on PEOU, PU and benefits, we were able to spot some repeating patterns, analyze more marginal information and gather a significant amount of new information during the process. Ultimately this enabled us to answer to the three sub-questions and hence build a solid base for the main research question. Moreover, we were able to see some holes in the current state of knowledge. These are listed in the recommendation for further research. Lastly, we acknowledge the limitations of this study as those impediments that prevented this work to answer to the research questions to the fullest.

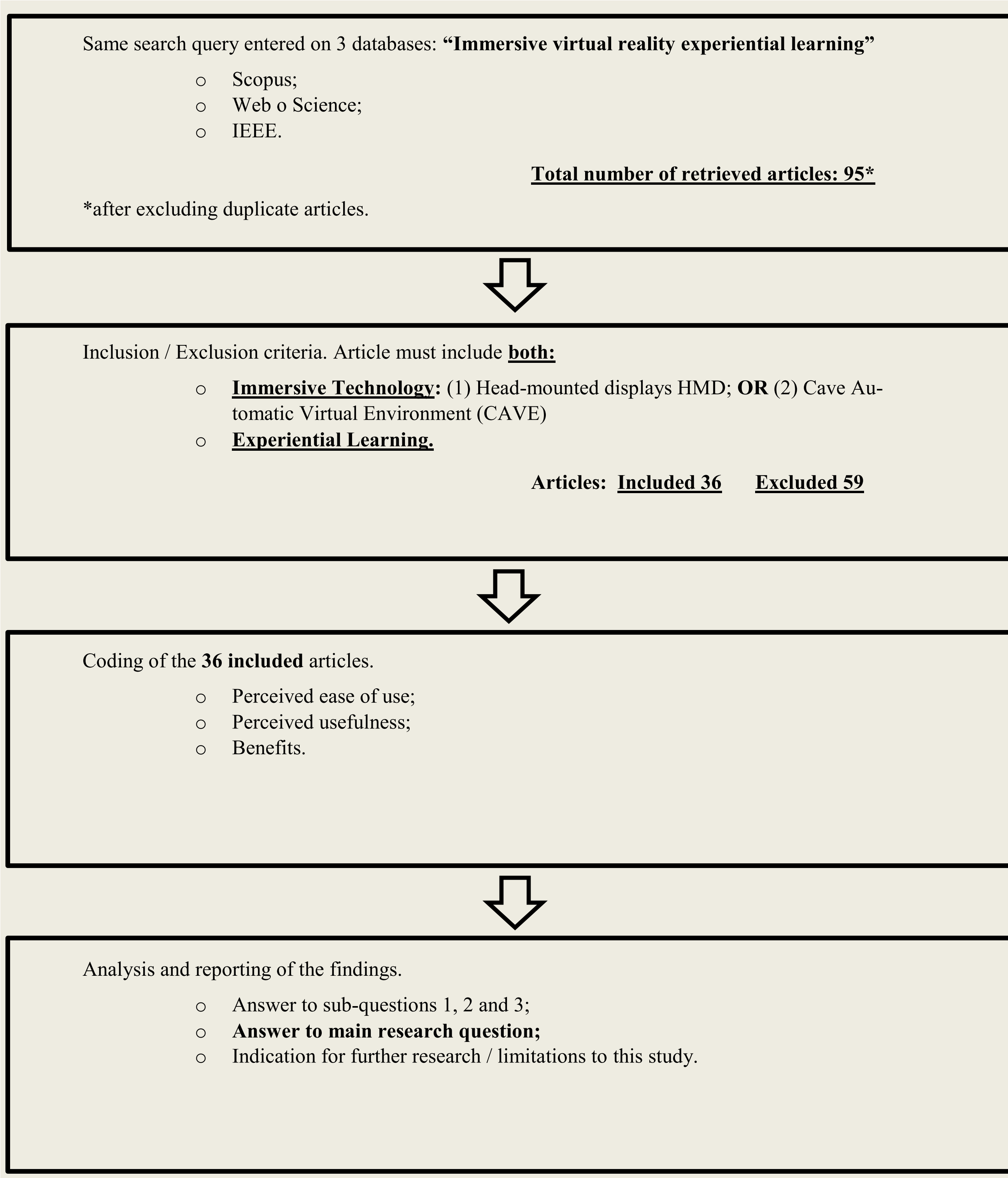

Figure 9: Steps in this research

We conducted a literature review following the process outlined by Kitchenham (2004), and searching the academic databases Scopus, IEEE and Web of Science. From this process, 95 papers were identified for further analysis. The full list of articles is in the bibliography together with other sources referenced in this manuscript. The whole process took many steps, divided in several stages. Sometimes, we had a clear vision that gave direction to the efforts, and sometimes we advanced through trial-and-error until reaching a final solution. In the beginning we decided to accept only the articles that contained both the exact terms “virtual reality” and “experiential learning” in the title. This yielded very few results, but with an overall decent quantity of relevant contents. After reading other literature reviews on VR in education, we got some inspiration. What if we use a longer search query? And so, we did. We entered “immersive virtual reality experiential learning” as the only keyword in three different databases (Scopus, IEEE and WoS). This research fetched 87 results on Scopus, 34 on Web of Science and 9 on IEEE. Once excluding those titles that appeared more than once, we had a final of 95 unique articles. A pretty decent dataset. At this point we could limit the articles in many ways. Surely we needed to have those where a VR based solution has been implemented in an educational context, and the authors clearly express their motivations behind and/or justifications for utilizing such technology Another inclusion criterium is whether authors performed an evaluation of the system with consideration on usefulness and ease of use, as these are the main criteria in the Technology Acceptance Theory.

Figure 10: Word cloud created in NVivo from the literature

5.5 Data

This literature review is based on data fetched from three very popular academic databases: IEEE, Web of Science and Scopus. The search criteria applied are the same for each database in order to give more credibility to the study. This technique is called triangulation and it is discussed in greater detail on the trustworthiness chapter. All the articles listed in the results are yielded using the search query “immersive virtual reality experiential learning”. No other filters nor limitations were used. Therefore, these results include any kind of article present in the databases from any year. All the searches were performed on March 13th, 2020. Results are listed and further described in the following paragraphs. A full list of references is available at the end of this thesis.

5.6 IEEE

Searching with the query "immersive virtual reality experiential learning" on date 13.3.2020, the database IEEE retrieved a total of nine results. The oldest article was published in 1997 while the most recent is from 2019. Thus, a timeframe of over twenty years is covered. Although VR technology has evolved a lot during the years, the core idea of experiential learning remained unchanged. Publications are very international: North America, Africa, Europe, Asia and Oceania.

5.7 Web of Science (WoS)

Searching with the query "immersive virtual reality experiential learning" on date 13.3.2020, the database WoS retrieved a total of 33 results. In this case, the oldest article is from 2003 and the most recent are from 2019.

5.8 Scopus

Searching with the query "immersive virtual reality experiential learning" in date 13.3.2020, the database Scopus retrieved a total of 84 results. Scopus is evidently the database with the largest number of articles. Again, the time range is very broad, with the oldest article published in 1997 and the most recent from 2020.

After listing all the articles from the three different databases, the first step is to look for duplicates. Some papers may in fact be published in more than one database. This is completely normal, as the keywords used in every search are identical, and offers a good place to start the research. To sum up and visualize the number of articles fetched and their source, we created the following Venn diagram.

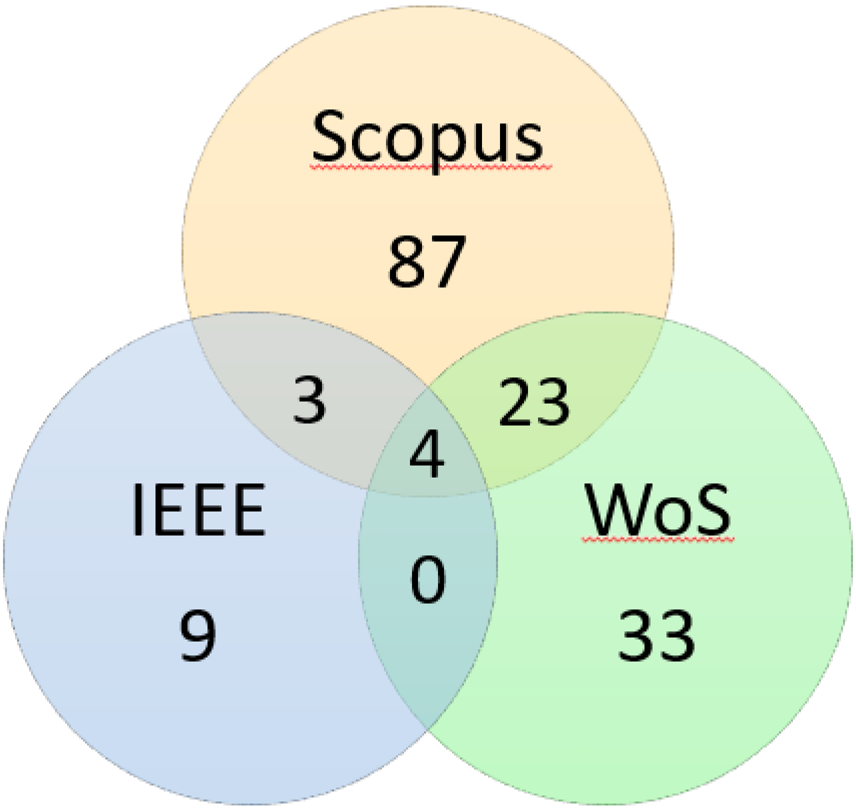

Figure 11: Venn diagram on articles collected by source

The original searches fetched a total of 87 articles in Scopus, 9 in IEEE and 33 on WoS. Of these, 4 were common to all databases, 3 were common to Scopus and IEEE only and 23 were common to both Scopus and WoS. Zero articles were common between IEEE and WoS only. After eliminating the doubles, a final total of 95 articles constitutes the dataset for this study.

5.9 List of articles

The complete list of 95 articles was manually analyzed in order to eliminate anything unrelated or irrelevant to the main focus of this study. After this screening process, only 36 articles remained. The two inclusion criteria used were: (1) immersive technology (HMD or CAVE) and (2) experiential learning. The following table lists all the papers. The first part contains the 36 included articles, while the second part includes the remaining 59 that were excluded. The reason for inclusion / exclusion of each article is also reported on the table, and so is the main topic of each paper.

Article	Immersive VR	Experiential learning	Field
	Included		
Dietrich et al. 2019	Yes	Yes	Social marketing (teens and alcohol)
Seymour 2018	Yes	Yes	Surgery training
Fakier and Van Den Berg 2019	Yes	Yes	Sport coaching in poor countries
Isabwe et al. 2019	Yes	Yes	Chemistry for children
Li et al 2019	Yes	Yes	VR Experiential learning for autistic children
Maghool et al. 2018	Yes	Yes	Architecture education
Civelek et al. 2014	Yes	Yes	Physics for teens
Ball et al. 2015	Yes	Yes	Dementia simulation
Bernardes et al. 2018	Yes	Yes	Geosciences
Allison et al. 1997	Yes	Yes	Gorilla exhibit for children
Elkind 1998	Yes	Yes	Neurological disfunctions diagnosis
Evans and Schares 2017	Yes	Yes	Mobile learning environment
Gilmartin et al. 2019	Yes	Yes	Maritime education
Gochman et al. 2019	Yes	Yes	Primate optics
Hsu et al 2018	Yes	Yes	Exaggerated feedback

Lin et al. 2018	Yes	Yes	Fire disaster prevention
Longo et al. 2018	Yes	Yes	Emergency training
Mantovani et al. 2003	Yes	Yes	Health care training
Mitsuhara et al.	Yes	Yes	Evacuation training
Vassigh et al. 2018	Yes	Yes	Teaching Building Sciences
dela Cruz et al. 2018	Yes	Yes	Virtual laboratories
Antoniou et al. 2017	Yes	Yes	Elderly care training
Hickman and Akdere 2017	Yes	Yes	Soft skills for STEM students
McFaul and FitzGerald 2019	Yes	Yes	Legal education
Mills et al. 2019	Yes	Yes	Triage training
Molka-Danielsen et al. 2015	Yes	Yes	Architecture education
Kwon 2018	Yes	Yes	Experiential learning using HMD
Pavlik 2017	Yes	Yes	Experiential media
Pierce et al. 2008	Yes	Yes	Medical education
Roshko et al. 2019	Yes	Yes	Design education
Roussos et al 1997	Yes	Yes	Virtual learning environments
Schott and Marshall 2017	Yes	Yes	situated experiential education
Stavroulia 2019	Yes	Yes	teacher education

Stefan 2012	Yes	Yes	Design education
Vaz De Carvalho 2019	Yes	Yes	Engineering education
Walsh et al. 2019	Yes	Yes	Virtual field trips
Total number of articles included	**36**		
	Excluded		
Abdullah et al. 2018	No	Yes	Written in unreadable English
Afrooz et al. 2019	No	Yes	Virtual worlds
Ahmed and Sutton 2017	No	Yes	Gamification
Alrehaili 2018	Yes	Yes	Master thesis
Arnab et al. 2010	No	Yes	Web based platform for ancient artefacts
Begg 2009	No	Yes	Serious games for healthcare
Dede 2009	No	No	Situated learning
de Freitas and Neumann 2019	No	Yes	Immersive learning
de Freitas et al 2009	No	Yes	Immersive experiences
Dobre et al 2019	No	Yes	Seismic protection
Vear and McConnon 2017	No	No	meaningful engagement in mixed reality
Dow et al 2014	No	Yes	Collaborative projects
Hai-Jew 2011	Yes	No	Research on VR
Hai-Jew 2011	No	Yes	Negative learning

Harrison et al. 2019	No	No	Space simulation
Heinrichs 2008	No	Yes	medicine
Hendricks et al. 2018	No	Yes	Cerebrovascular anatomy
Hew and Cheung 2010	No	Yes	Virtual worlds
Hill and Knutzen 2017	No	Yes	Virtual worlds
Ip et al. 2011	No	Yes	Affective learning
Ip et al. 2018	No	Yes	Affective learning
Irwin et al. 2019	No	Yes	Nursing education
Karageorgiou et al. 2019	No	No	Gamification for STEAM
Knox and Gregory 2012	No	Yes	Virtual worlds
Lane 2009	No	No	Metacognition
Le Marc et al. 2010	No	No	Serious games
Lorenzo-Alvarez 2018	No	No	Radiology education
Loureiro and Guerreiro 2018	Yes	No	Psychological behavior of millennials
Makhija et al. 2018	No	Yes	Influence of gender in virtual worlds engagement
McDonald et al 2010	No	Yes	Virtual worlds for medical education
Menezes et al. 2017	No	No	Affective computing
Mikropoulos et al 1997	No	Yes	Environmental education

Mitra and Saydam 2013	No	Yes	Mining education
Moissinac 2016	No	Yes	Child health behaviors
Moller et al. 2014	No	Yes	Wellbeing promotion
Mystakidis et al. 2017	No	Yes	Distance learning
No autor 2012	No	No	Production Management Systems
No autor 2014	No	No	e-learning
No autor 2017	No	No	Applied perception
Oliver et al. 2013	No	Yes	3D web
Pallot et al. 2012	No	Yes	Living lab for innovation
Pinto and Costa 2018	No	Yes	Serious games
Rafi et al. 2017	No	Yea	Design education
Rizzo et al 2012	No	Yes	Post-traumatic stress disorder treatment
Sanchez et al. 2005	No	Yes	Virtual field trips
Santarelli et al. 2004	No	No	Cultural training for soldiers
Stewart et al. 2009	No	Yes	Nursing education
Stieglitz et al. 2010	No	Yes	Virtual worlds
Stieglitz and Lattemann 2011	No	Yes	Experiential Learning in Second Life

Stieglitz and Lattemann 2012	No	Yes	Challenges for lecturers in virtual worlds
Green et al. 2013	No	Yes	Virtual worlds for nursing education
Wood and Hopkins	No	Yes	3D virtual environments
Yu-Che and Yi-Ru 2019	No	No	Education Learning
Seymour 2008	No	Yes	Surgery training
Herpich et al. 2017	No	Yes	Electricity in virtual worlds
McConnell et al. 2017	No	No	Parts design
McCaffery et al. 2014	No	No	Internet routing education
Saunder and Berridge 2015	No	Yes	Nurse training
Lewis et al. 2011	No	Yes	Serious game for road safety
Total number of articles excluded	**59**		

After a first analysis, it emerges that technical disciplines are clearly the ones with the highest number of immersive VR applications for experiential learning, see figure below. This could be due to the fact that such fields require a significant time spent practicing. The settings for such practicing are often hard to set. High costs and dangerous environments are definitely a barrier to practicing certain educational experiences (Kauer interview 2019). In healthcare, for instance practitioners need to be able to deal with matter of life and death situations. Training for disaster prevention and rescue can be very demanding as the number of people involved for staging such settings is remarkable, operations are very time consuming and hard to replicate often. Sometimes experiential learning settings might even be illegal, as it is the case with alcohol use by teenagers, nevertheless, teaching youngsters the dangers of substance abuse, is critical. Virtual reality is a solution for all these problems, as it can be replicated any time anywhere and at zero risk. The following chapters presents the analysis of the findings from this literature review and try to answer to the research questions of this study.

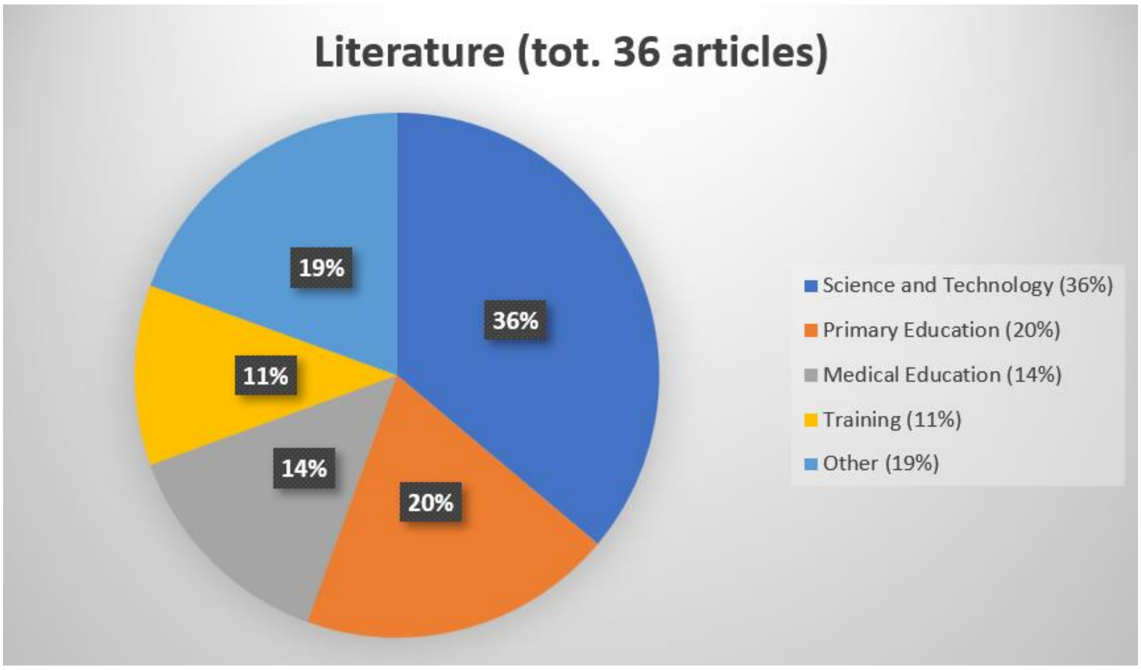

Figure 12: Fields of application from literature

5.10 Inclusion / exclusion criteria

Once identified the literature sample, a researcher needs to skim through it to define what articles are worth including in the research and which ones need to be kept out. This step is fundamental to narrow down the research and focus only on the relevant materials. Moreover, a more focused research adds in integrity and ultimately brings results of higher quality. At this stage the researcher needs to know what is needed for the research. Knowing what to look for helps defining the inclusion and exclusion criteria. Inclusion criteria are the requirements an article needs to be utilized as a source for the research. Having clear and well-defined list of these, is fundamental to eliminate unneeded materials and focus on what really matters. On the other hand, exclusion criteria are those used to cut out an article from the literature. Obviously, an article that does not meet the inclusion criteria is automatically out of the sample. However, there might be other criteria that eliminate an otherwise suitable article. These are called exclusion criteria. The following list of inclusion and exclusion criteria are used in evaluating the articles:

(1) Is it an academic article?

All the papers in this literature review are academic articles. Everything else was excluded: master thesis, conference review, magazines etc.

(2) Does the article describe an attempt/experiment to use immersive virtual reality?

The subject of this research is immersive virtual reality. Hence, all articles utilized in this review must focus on it. It is worth noticing that although immersive virtual reality was one of the keywords utilized in the initial research, the term is used sometimes to refer to different technologies. In this study I consider as immersive VR only head mounted displays and CAVE.

(3) Was immersive VR used for learning purposes?

The second focus area of this research is education. All articles included in this research share the common trait of educational VR. The principal interest area of this study is university education. Although many articles analyze and expose experiments conducted in university settings, some of them addressed a different audience. Nevertheless, some articles where the use of VR is targeted to others than university students, are still included into this study. This choice was made because of the next inclusion criterium.

(4) Can the learning method from the article be considered as experiential?

Experiential learning is the second pillar of this research. For this reason, all the papers where some sort of experience was staged in VR, as long as the final goal was educational were finally included in this literature review. Articles with anything related to experiential learning are included regardless of the target group. This sort of compromise helped providing different points of view. And in author's opinion all levels of education are equally important and therefore equally worth investigating. Finally, findings from lower levels of education can still be generalized to university education.

(5) Is feedback collected, discussed and analyzed?

The final pillar of this study is the technology acceptance model. Hoping to find articles that include all the theories of interest for this study would have been a fool's errand. Fort this reason, the last inclusion criterium is generic enough to allow in anything that has some sort of feedback from users. The next step would then be to analyze those feedbacks and conclude whether they meet the requirements to be categorized under the labels of perceived ease of use and perceived usefulness.

5.11 Coding

Conducting a systematic literature review includes analyzing a lot of written data in form of journals and articles. In order to create coherent, systematic overview of this data, coding was used to rearrange data into controllable sample, and identify relevant information within the articles. In general, codes are formed from research questions, assumptions on research results or themes (Miles & Huberman 1984, 54). Similarly, the coding in this study was based on the research questions and the theoretical background of the study, focusing on the perceived usefulness, perceived ease of use, experiential learning, as well as benefits of using VR in experiential learning context. The academic research literature presents two main approaches to coding: concept-driven coding and data-driven coding (source) and in this research, concept-driven approach was used: the final list of articles

were carefully examined to identify content that matched the predefined codes derived from the research questions. However, to address content that did not fall into the predetermined coding scheme but that was related to the research questions, any emerging themes or codes were added to the analysis.
Three main coding nodes are used to answer the three research sub-questions, one for each. These are: (1) perceived usefulness, (2) perceived ease of use and (3) benefits.

5.11.1 Perceived usefulness

As the Technology acceptance model constitutes the main theory for evaluating the dataset, we need to code how VR has been perceived during those trials. Therefore, we code under this label, every mention of usefulness either before or after the real testing. Usefulness can be expressed by many stakeholders: university administrators (provost), teachers and students. However, the most valuable feedback comes from final users, hence professors and students.

5.11.2 Perceived ease of use

Under this label, we code every mention of how final users felt about using immersive tools. By users we mean both teachers and students, again their feedback is the most valuable and reliable for this study, thus we pay special attention to it.

5.12 Trustworthiness

The most common criteria used in qualitative research for trustworthiness are: credibility, transferability, confirmability and dependability. In addition to the theoretical part, here we also expose how this work tries to meet those criteria that ultimately make it a trustworthy contribution to the current state of academic knowledge in the use of immersive virtual reality for experiential learning.

Whereas in quantitative studies, trustworthiness is referred to validity and reliability, in qualitative studies, this concept is different. The lack of tools with accountable metrics about validity and reliability is filled with proofs that ensure the solidity of a qualitative research's findings. These are: credibility, transferability, confirmability, and dependability. These four pillars, illustrated in figure 12, below, are at the base of trustworthiness in qualitative studies (Connelly et al. 2016, 435). A qualitative researcher can utilize a set of instruments to guarantee the solidity of these four pillars and thus the trustworthiness of the whole study. The four pillars and the ways to prove them are discussed in the following sub-chapters.

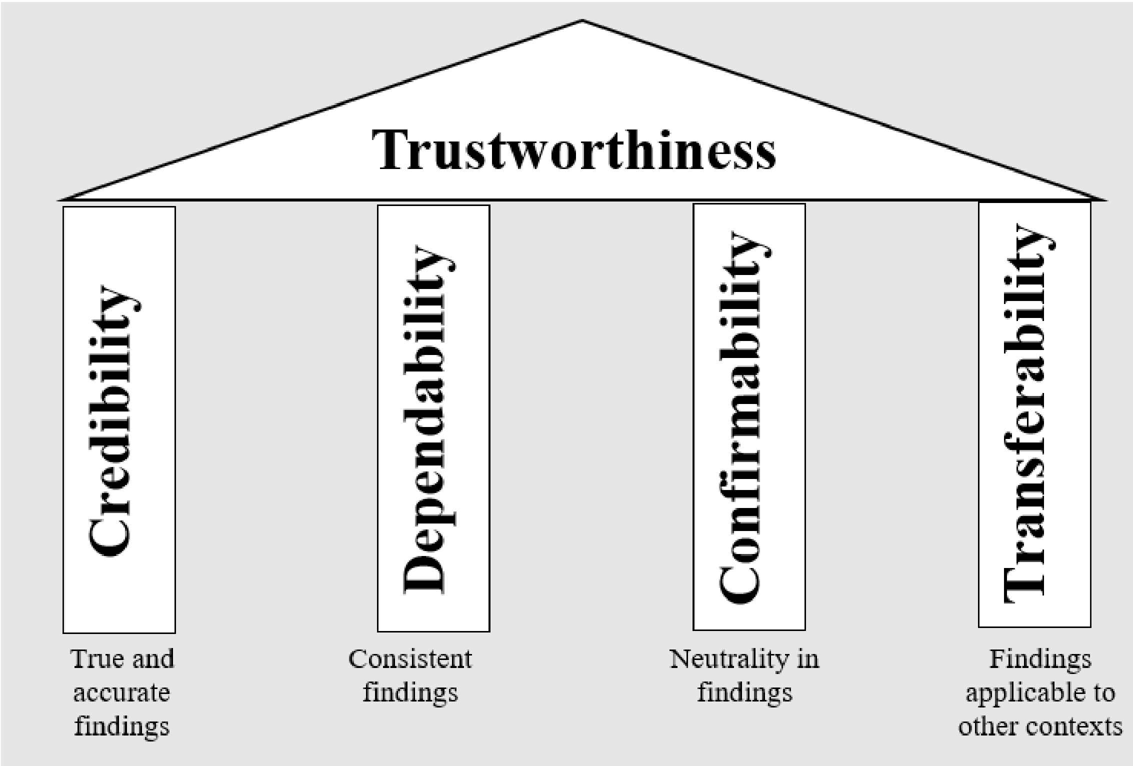

Figure 13: The four pillars of trustworthiness (Connelly, 2016)

5.12.1 Credibility

Credibility is the first and most important pillar to support trustworthiness. Qualitative researchers need to be sure about the truth of the findings their research studies bring. In fact, credibility links the study's findings with reality and therefore demonstrates the truth of the findings. There are several techniques available to establish credibility. The two most commonly used are triangulation and member checking. (Connelly et al. 2016, 435)

Triangulation is used to ensure that the research findings are robust, rich, comprehensive, and well-developed. The methods used in triangulation facilitate a deeper understanding of the phenomenon of interest. Triangulation can be performed in numerous ways. For example, the use of different methods for data collection can bring a stronger consistency to the findings. Or, the use of different data sources with the same method can prove a relation between different populations or data sets. Sometimes, the collaboration of more

than one researcher in the same study can also bring more value as two pairs of eyes do a better job than one. Moreover, the findings can be scrutinized with different existing theories, in order to prove their validity. The other way to prove credibility is sharing the findings with participants, for example after analyzing interviews. This is called member-checking. Doing so confirms the real intention and meanings of what has been said, thus eliminating any possible doubt on researcher's biases. (Shenton 2004, 65)
The credibility of the present manuscript is proven using several of the methods listed above. First of all, more than one data collection method was used. A deep interview with an expert in VR with many years of experience was performed at the very beginning of the study (Kauer interview 2019). The findings that emerged during this interview were kept as a reference during the whole process of analysis of the literature. Second of all, the data collected in literature was accessed using the exact same method from different databases (same search query), in order to access a broader set of data and verify the relations between different sources. Third of all, all articles were read, coded and analyzed by each author separately and independently, and then compared in order to avoid biases.

5.12.2 Dependability

A study's findings must be consistent in case the same study would be repeated by other researchers. If a study can be proven to be repeatable, then there is strong evidence that its findings are consistent with the raw data collected and analyzed. The most efficient way to prove dependability is to have another researcher conducting the exact same study, hence working as auditor. An auditor's job is therefore to examine the whole research process and assure that everything has been done with a certain degree of accuracy. (Shenton 2004, 66) At the time of writing, no audit has been planned for this study, however, both authors are open for future collaborations.

5.12.3 Transferability

Transferability occurs when findings are applicable to other contexts, hence findings are generalizable. Other contexts can mean similar populations, similar situations or similar phenomena. No researcher can prove with absolute certainty that the findings will be applicable, but rather provide evidence that they could be. (Connelly et al. 2016, 436) Among the numerous techniques that enable to establish transferability, thick description is one of the most commonly used. Thick description is a technique where a detailed account of everything that happened during the research process is reported. For example, the cultural and social contexts around data collection can be listed. Where and when the interviews took place, can tell something about the participants attitude and feelings Such information allows outside researchers to make transferability judgements by themselves. (Shenton 2004, 67-68) As this study relies for the most part on secondary data, literature, a thick description of data collection remains inapplicable. However, the choice of using the technology acceptance model, is supported by a strong conviction that the dogmas behind acceptance of new technologies are universal.

5.12.4 Confirmability

Confirmability is the final pillar of trustworthiness. Findings must be neutral, hence unbiased. In order for this to occur, findings must be uniquely based on respondents' words, and never on researchers' personal opinions or motivations. A good researcher is capable of interpreting data correctly and provide an audit trail, highlighting every single step taken during the research process and every decision made. (Connelly et al. 2016, 436) Moreover, an audit trail is extremely handy when writing the results chapter. Here, the details of the data collection process, data analysis, and interpretation are presented, discussed and explained. Another common technique to proof confirmability is reflexivity. Reflexivity is more of an attitude that the researchers assume during the process, looking at their backgrounds and position, while being aware of how these might affect the outcomes. A simple way to do this is simply to keep a journal of diary, where everything is written down during the process. (Shenton 2004, 70-71) All the steps undertaken during the entire research process in this study are reported in the present manuscript. We, the author tried his best to collect data, analyze the literature and report findings in an unbiased way, after meticulously assessing the previous knowledge on the field and avoiding any possible external influence that might have affected the quality of the work.

6 DATA

7 FINDINGS

In this session the fragments of text extracted from literature are presented and organized analytically. Some of the most significant parts are quoted directly, however, due to the vast quantity of data, most of the coding is reported only through schematization and synthesis. Nevertheless, the findings are exposed in a comprehensive way, in order to deliver a clear and understandable overall picture to the reader. Findings are thematically organized, according the needs of this study, this choice aims to provide exhaustive answers to the two research sub-questions. The two main themes are: Perceived ease of use (PEOU), and perceived usefulness (PU).

"The benefits of virtual reality within a learning environment are numerous including outstanding visualisation, not possible in traditional classrooms, increased student engagement and the elimination of language barriers. The main benefits of virtual reality are learning enhancements via experiential learning, increased user engagement and access to data." (Fakier and van den Berg 2019, 3)

7.1 Reporting

After reading, analyzing and coding with the NVivo software all the 95 articles, and in deeper detail the 36 articles that make the final literature, I found many of the issues emerged during the initial interview with Kauer (2019) to be confirmed. We could not find any article dedicated entirely to what the interviewee considers pivotal: how people learn in VR. On the contrary, we found many cases where the use of VR has been tested in an educational set, and feedback collected from users. In some cases, A/B testing was used to compare whether those students who used a VR software retained more information than those who used more traditional tools. The results are encouraging, with a favorable outcome for VR. Fields of application were very diverse, from elementary pupils to university students, from teaching languages to emergency rescue training. In particular, one field stands out above all: medical education. The number of articles for this sector is the highest of all. Technical disciplines such as architecture, engineering and STEM had also a high number of papers in the literature. But what came as a surprise was the high presence of articles dedicate to a different yet somehow similar technology: Virtual Words. In particular, an online service launched in 2003 mainly for entertainment

purposes has been widely used in educational environments too. Second Life is a web based, virtual world where users can navigate using their web-browsers. Although unrelated to the study, as accepted as immersive technologies only HMD and CAVE, and not web-browser websites, the vast employment of Second Life by educational institutions suggest that upgrading this technology could open new opportunities both for schools and for firms willing to pursue this opportunity. In fact, virtual worlds could be browsed with HMD, enabling a full immersive experience.
The number of academic articles published is massive. What we found during the research on databases proves this without any reason of doubt. The earliest experiments of virtual reality using head mounted displays are more than 20-year-old.

7.2 Perceived Ease of use

As already discussed in chapter 3.6.2 perceived ease of use is the lack of difficulties when using a new technology. Again, this is something that can be sometimes tricky to assess, as every user is unique. However, as dela Cruz (2018) shows, users are often keen to share their opinion in anonymous surveys. Surveys offer a reliable tool to understand and assess the way users feel about a certain technology, moreover, as survey are in most cases anonymous respondents are more incline to tell the truth, hence response biases are reduced. It is important to notice that although the term "PEOU" is not present on the following text, the synonym "usability" expresses the same idea. In this case, users' response was very positive, with an overall mean of 4.188.
"The proposed system was evaluated by using Likert Scale. The level of acceptability of the application when it comes to its reliability, cost, maintainability, safety, usability and efficiency. The survey participants, which consisted of 50 students, gave the system a very satisfactory rating for the aforementioned areas. The overall mean is 4.188, which is a very satisfactory rating." (dela Cruz et al. 2018, 22)

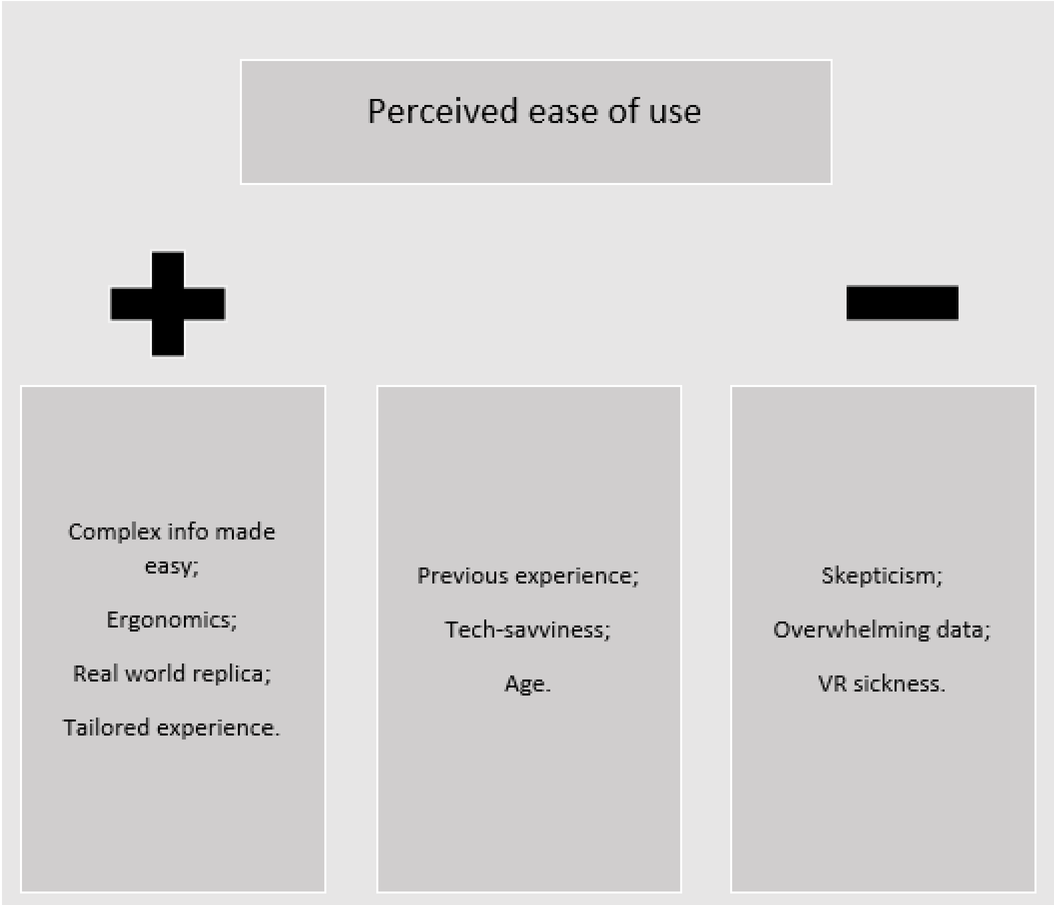

Figure 14: Factors affecting PEOU in VR

Undoubtfully, previous experiences affect the way users perceive a new technology. It is therefore important to keep in mind users' backgrounds when assessing the PEOU of a new technology. Fabola and Miller (2016, 70) underline a weak correlation between users' previous experiences with VR and PEOU. This suggests that VR technology has low barriers to new users. e-Gaming has seen a massive surge in recent years, especially among millennials. E-games are so popular that many consider them equal to sports. Some even would like to add them as a discipline in Olympic games. However, it is worth remembering that for how popular e-gaming might be, not everyone is into e-sports. It is therefore critical when assessing the PEOU whether users are familiar or not with navigating in 3D virtual games. Ball et al. (2015, 22) found out that the majority of users feels at ease with immersive VR. From this, it emerges that VR environments are as easy to navigate as the real world is. By simply looking towards the direction of interest, users can decide where to go. The proved similarity with the real world is definitely a clue that immersive technologies are perceived as easy to use.

Personal computers became very widespread in the rich world right after the early 2000's. A few years later, the boom of smartphones provided the majority of people in rich countries with a constant access to the internet, and ultimately the convenience of portable ICT services. Nevertheless, in assessing PEOU for VR it is important to keep in mind that computer skills represent a clear advantage over those people who are less familiar with technology. Isabwe et al. (2018, 224) pinpoints how previous computer skills remain unnecessary for using VR with a reasonable degree of confidence. Millennials are the people who were born between the early 1980's until the mid-1990's. These people are much more familiar with any kind of technology than previous generations. Age as well as generational factors play a key role in PEOU as previous experiences count in favor of those who benefit from them. (Green et al. 2013, 5)

One of the main functions of ICT systems is to provide instant access to data. We live in a data hungry world where individuals, firms, governments and organizations are more and more reliant on access to data. Dietrich et al. (2019, 808) highlights the ability of VR to make complex information easily accessible with an engaging experience. Often these experiences can be tailored, hence personalized to users.

Sometimes high performances come as a trade-off with convenience. This is not the case with HMD, that are both highly immersive and convenient. A lightweight HMD can be carried around everywhere, it fits in a small handbag and requires a minimum knowledge of ICT to be used. But more importantly the experience it provides is highly immersive (Li et al. 2019, 3) An HMD feels good to the person wearing it, it is ergonomic. Moreover, the average home computer is powerful enough to provide a decent immersion in VR. (Li et al. 2019, 3).

Education requires access to different sources of information, sometimes with little time to switch from one another. Maghool et al. bring up an interesting point as it compares flexibility of VR with more traditional educational tools used in university classes. "Almost all the participants implied that this application is far more flexible compared to traditional classes at the university because they have an opportunity to decide when, where, and what to learn" (2018, 265). This is not only a point in favor of PEOU but also a clear benefit. However, although VR can deliver an instant access to vast amounts of information, this can sometimes be overwhelming. (Maghool et al. 2018, 265)

VR tries to replicate real world experiences. User interfaces might be one thing of the past. The main focus is intuitiveness. (McConnell et al. 2017, 6 and McCaffery et al. 2014, 6)

Teachers are users of immersive VR as well as students are. It is therefore important that their PEOU relates with facilitating their job. (Mantovani et al. 2003, 391)

To conclude, Green et al. reminds us the importance of constant improvements to technology in order to minimize frustration and unease in users. “The limitations of the technology can also potentially cause frustration and confident participants can become shy, inhibited and angry.” (2013, 5). Usability is therefore the best way to go when developing new VR.

7.3 Perceived usefulness

Users’ attitude towards technology determines their acceptance of it. More specifically, Perceived Usefulness (PU) is a very clear indicator of user’s attitude and sentiment. By definition, PU is: "the degree to which a person believes that using a particular system would enhance his or her job performance." (Davis 1989, 320). It is important noticing that PU relies entirely on users believes and is not therefore an objective measure of the real benefits a technology brings. It is rather more of an indicator of users’ perceptions. Manis and Choi define perceived usefulness as “the degree to which a person believes using a particular system would be beneficial and advantageous (2019, 505). After reading, coding and analyzing all the articles from the literature it emerged that the factors supporting users perceived usefulness of VR outweigh those opposing it. More specifically, higher engagement, suitability to all learning styles, lack of time-space constrains and the possibility to safely reproduce any kind of activity are the factors that strongly emerged as supporting VR perceived usefulness. On the other hand, the overwhelming nature of immersive VR together with the lots of distractions that these contain were sometimes felt like two possible drawbacks in the use of this technology. Overall, it emerged that the use of VR is nevertheless useful to produce better learning and better teaching.

Pierce at al. (2018, 1) question the usefulness of HMD. Reporting no significant difference between users using HMD and those using other tech. Skepticism on the use of technology is the first barrier to adoption. Often the use of older tools and technologies just seems more convenient. On the other hand, Walsh et al. (2019) provide a long list of advantages from VR: “(1) Active rather than passive experience, (2) Immersive experience means no distractions, (3) Immediate engagement: useful in today’s world of limited attention spans, (4) Exploration and hands on approach aids with learning and retention,

(5) Helps with understanding complex subjects/theories/concepts and (6) Suited to all types of learning styles, e.g. visual" (Walsh et al. 2019, 1).

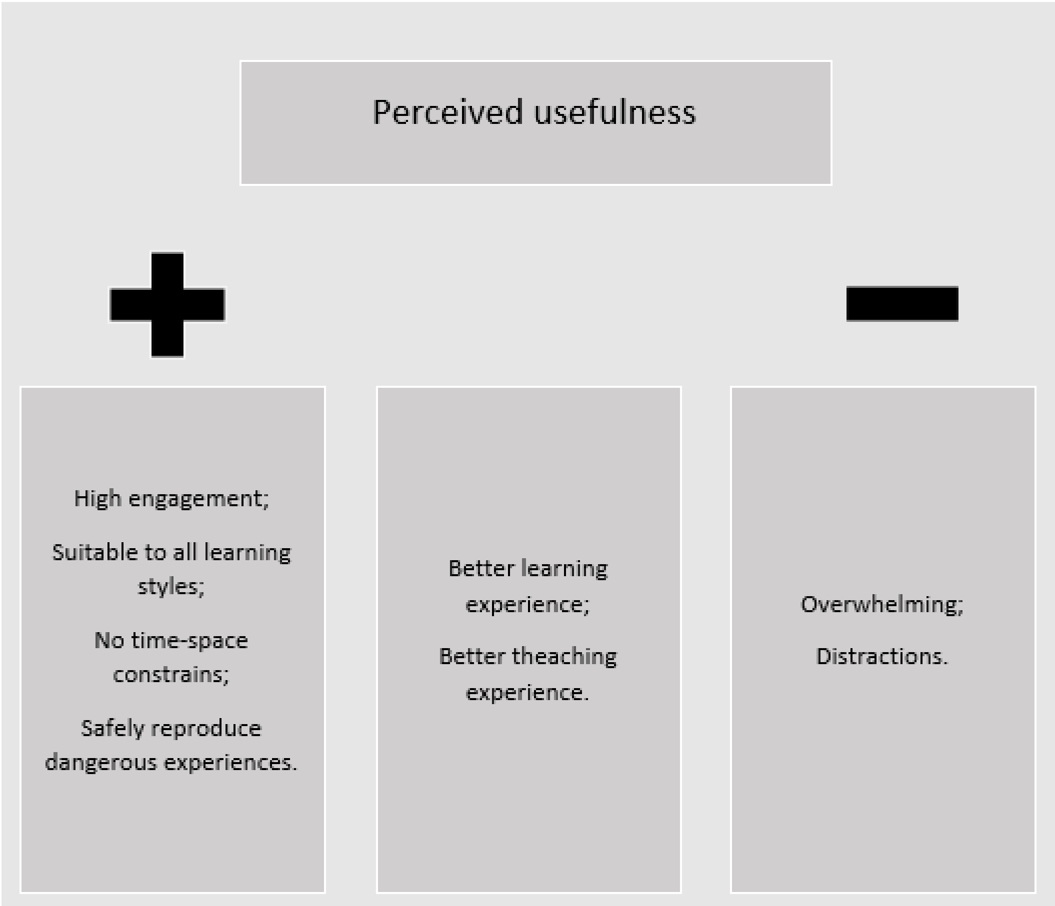

Figure 15: Main factors behind PU in VR

Maghool et al. highlights the high level of compatibility between VR and experiential learning: "the characteristics of immersive VR and the axioms of constructivist learning theory are entirely compatible" (2018, 255).

The Technology Acceptance Model (TAM) relies entirely on subjective opinions from users. Lin et al. (2018, 948) report outstanding results after testing a new VR system. In their study over 70% of students "believe" that VR boosts interest and facilitates learning. However, it is important to notice the use of the verb "believe", that makes the whole statement a subjective opinion. Nevertheless, the fact that 70% of students are convinced, plays a big role in favor of VR and its perceived usefulness.

Allison et al. (1997, 37) pinpoint the importance of experience. In fact, experiences are first-person, and interactivity is high. Everyone can see things from different points of view when using VR. This is true also when reproducing dangerous situations, which are completely safe in a VR environment. All the inconvenience and dangers of staging such experiences in the real world disappear in VR. Walsh et al. (2019, 1) stress one more the high level of engagement at a classroom convenience when using VR. The wonders of the world can be seen without leaving the class. Moreover, the level of engagement is far superior (Mc Caffery et al. 2014, 2) and can be both used individually and in groups (Li et al. 2019, 5)

It is important to remember that in education, VR users include not only students, but also teachers. Keeping in mind both categories will deninetely help develop better hardware and most importantly software solutions. With a such fast-evolving world, where new technological developments require constant competence updates and skills to be improved, VR "can be used to support teachers' continuous professional development through systematic, individualized training." (Stavroulia 2019, 44) Moreover, immersive virtual reality, breaks the walls and restrictions of the real world and enables a new series of educational settings. The possibilities are immense, however so far, some have emerged as dominant. Situated learning together with authentic problem-solving are two excellent examples of new forms of learning that can be delivered in VR. Creating suitable setting for situated learning can be challenging in a traditional classroom. But this changes completely in VR. Virtual simulations of authentic problem-solving environments populated by both human users and virtual entities, are a powerful and effective tool that enhances, facilitates, and encourages interaction and therefore boosts learning. (Dede 2009, 66)

The greatest strength of immersive VR is the possibility to virtually create and recreate any possible environment. These might include the reproduction of ancient civilizations and the spaces and cities they lived in. In this sense VR can make time travelling possible. Undoubtfully a great tool to teach history. "History students can learn about ancient Greece by walking in its streets, visiting its buildings, and interacting with its people" (Rickel 2001, 15). On top of the massive potential, VR environments are relatively inexpensive (once the software exists, the experience can be reproduced unlimitedly at neglectable extra cost). Moreover, risks are limited to the minimum or better eliminated completely. No health risks linked to the visit of exotic places infested with dangerous diseases (Maghool et al. 2018, 253), no risk of physical injuries when performing dangerous activities or visiting hazardous places. And this is particularly relevant when there is the need to teach complex and dangerous skills, where the human error can have lethal consequences. The risk of damaging expensive equipment is also eliminated (Santos & Carvalho, 2013, 212, Civelek et al. 2014, 567). Anyone who ever visited a museum knows well that nothing is there can be touched. This is no longer the case in VR museum tours, where even the most valuable objects (or better, the virtual version of them) can be hold by any visitor, without any risk. (Yu-Che and Yi-Ru 2019, 10).

The oldest article in the literature included a VR simulation for showing gorillas to school children. As the natural environment where these mammals live, remains inaccessible to field trips, zoos are the only option left to admire these gorgeous animals. However, animals hold in captivity still have their routines. And these limits the time they can be observed. Thanks to VR this experience too can be replicated anytime without bothering nor harming any animal. (Allison et al. 1997, 30)

Dietrich et al. (2019) present a study where VR was used to teach youngsters the problems related to abuse of alcoholic beverages. In a real-world setting, serving alcoholic beverages to people underage is illegal, however there is no restriction on VR booze. This particular example elucidates the power of experience. Kids are particularly curious about the world and therefore want and need to experience as much as they can. And of course, this is in most cases a good thing. However, certain experiences might present a too high risk. Recreating a scenario where children can safely experience what can go wrong and what are the consequences of excessive alcohol consumption might prevent them from feeling the need to go through the same experience in real life. (Dietrich et al. 2019, 816)

Experiential learning in healthcare offers numerous possibilities for the use of VR. In many cases in fact, the practices and development of certain skills needed in this field are not dangerous to the person practicing or performing certain action but might have irreversible consequences for others. Surgery is the perfect example of this. A surgeon's training requires both hours of practice and patient to practice with. But mistakes are not an option here. Healthcare education in general requires a significant amount of time spent practicing and experiencing of fieldwork. For many reasons, setting a suitable environment for such practice is often problematic. VR overcomes this difficulty thus facilitating experiential learning through simulations (Seymour 2008, 87, Antoniou et al. 2017, 1).

The examples above show clearly how VR is an extremely versatile tool for experiential learning. "Opportunities for the use of virtual worlds are only limited by the imagination and cost" (Green et al. 2013, 4). A wider adoption and therefore a larger creation of new virtual worlds for educational purposes shall be encouraged by the fact that experiential learning in VR is not only more engaging but also transferable. Hence, VR helps to "raise interest and motivation in trainees and to effectively support skills acquisition and transfer, since the learning process can be settled within an experiential framework." (Mantovani et al. 2003, 389) The future of VR education places learners at the center. Providing authentic experiences and encouraging even more active participation. "VR experiences allow users to be active learners, constructing meaningful knowledge from first-person experience, and perceiving the world from other perspectives." (Alrehaili 2018, 4)

Immersion is key to great VR experiential learning. As already mentioned in several points of this paper, the concept of immersion is cultural. As technology develops, the agreement on what is immersive and what it is not changes. New developments in technology need to keep this in mind as a key aspect for efficiently delivering experiential learning. (McFaul and FitzDerard 2019, 4) Through immersion and interactivity

VR delivers experiences directly to users who enjoy the value of learning first-person.

"First-person experiences play a central role in our activity in the world and our learning about it" (Mantovani et al. 2003, 390)

The experiential learning circle includes active experimentation as a fundamental step. Evidence proves that creating in VR is not only possible but also highly recommended.

VR needs to combine a high level of interactivity with the possibility to create and experiment what has been learned. (Dow et al 2014, 1)

"VR offers the potential for authentic environments in which to enact the "plan, act, reflect" cycle in skills acquisition (Dede, Jacobson, & Richards, 2017) where a learner first prepares for an experience they wish to master, attempt its performance and then assess their effectiveness, which is central to the aims of clinical legal education." (McFaul and FitzDerard 2019, 3)

Even people with proven difficulties in focusing, such as those with autistic syndrome disorder (ASD) manage to interact with virtual contents when wearing an HMD. (Li et al. 2019, 2) To conclude, VR can easily fulfill new generational needs. As younger generations enter education, their demand for more modern technologies to meet their learning demand and curiosity will most definitely push the rise of VR. As Irwin et al. (2019, 1) puts it: "A number of disciplines in higher education are opting for the use of contemporary software approaches that serve as valuable adjuncts for the delivery of learning content. This satisfies the students of today who demand experiences that are instantly gratifying, engaging and flexible."

8 CONCLUSION

The vast majority of evidence collected in this work strongly supports the idea that immersive virtual reality is a viable tool to deliver experiential learning. VR itself is an experience. Experiencing in VR can have the same if not even stronger effects that experiencing in the real world. In fact, with good VR, users can barely tell the difference. Moreover, delivering experiences in VR is much more convenient than staging experiences in the real world. Reasons are numerous: lower cost, lower risk, fewer time-space restrictions, endless possibilities.

Lower costs are a good place to start. As the analysis shows, any experience can be staged in VR, including those which require the use (and possible damage) of very expensive machinery, or endanger users or other people. The economic benefit of this is enormous. It is easy to put a price tag to equipment, but the same cannot be done to human life. Training in VR eliminates both these unpleasant tasks. And this covers for a great part the risk too. Risks can be both for people involved in the experience or the machinery utilized. But again, in virtual worlds, everything is undoable, there is no life-threatening risk and no damage occurs with human error. Experiences in VR are always available and can be repeated anytime anywhere. Finally, VR not only enables the creation of real-world sceneries, but also of imaginary ones. Therefore, the only limit to what can be done in VR is the imagination.

Although some people experience VR sickness when putting on a HMD set, often this feeling of unease disappears with practice. Most importantly however, the ease of use of VR is so remarkable that even first timers find it intuitive, but most importantly even people with little or no experience with computer technology can easily start right away VR without any major barrier.

As any other research, this work too has its limitations. The main one being the total reliance on other people's jobs. However, the vast literature provided a fairly reliable amount of data to conclude that the findings are trustworthy. A lot more research can be done on the field. In particular, a stronger focus on the relations between stakeholders could be very beneficial to understand how to speed up this technology adoption and how to further develop it for future generations of teachers and students.

8.1 Theoretical Contribution and Managerial Implications

As in every study, the main goal is to provide some useful insights that find their application in both theory and practice. Moreover, an International Business study like this one, needs to bring something useful on a managerial level. This paper looks at the research problem from a different angle than the numerous previous studies on the topic. The combination of Experiential Learning theory with the Technology Acceptance Model intends to fulfill these purposes. When considering Immersive Virtual Reality as an educational tool, Kolb's model provides the theoretical framework to collocate this study on the map. As emerged from the analysis of the literature, the circle's four steps constitute a crucial combination for the effective application of VR in education. The experience needs to be first experienced, then rethought and mastered to the point of coming out with something useful from it. The user, as a consumer of experience, remains the protagonist and as such assimilates what the experience offers and ultimately benefits from it as an added value to the knowledge previously collected. For this reason, the experience has to be interactive and enable users to practice what they previously learned. These theoretical findings have also managerial implications. In this particular case, implications are both for the providers of education (universities) and for their suppliers or content creators (firms). In fact, these two actors need to implement a stronger collaboration in order to produce better results and ultimately a more efficient use of this technology. Profit-driven companies act as a big boat that leads the way into stormy waters, while academia is the anchor that slows the impetus and hazard. Although at a first glance these two figures might seem to have an opposite role, in fact, their ultimate goals are similar. In fact, instead of frictions and tensions, companies and academia need to build stronger synergies to navigate towards better learning experiences with a more efficient use of state-of-the-art technologies. These synergies will eventually bring both profitable returns for companies and a higher level of preparation for both students and teachers. The goal is to aim at results that are beneficial to all stakeholders involved to make everyone better off.

8.2 Limitations

Conducting a literature review on a topic such as VR created a certain degree of distance between the topic under scrutiny and the author. Relying entirely on someone else's work meant that there was all the time a certain level of remoteness from the experiments, the interests on those studies and the purpose. A much better approach would have been to run my own experiments, submit my own questionnaires and possibly develop and test my own software. But of course, that would have been a completely different kind of study.

Possibly the main challenge in this work was the coding. How to interpret other researchers' motivations goals and findings. Every study has its own purpose and yet we were here trying to find a linkage between articles from very different fields, written in very different times and remote geographical regions.

The diversity of literature meant that often we had to compromise in order to give some sort of continuity to the work. On the other hand, it is very hard, if not even impossible to find a large enough sample of articles with the exact same purpose, methods and interests.

All these things said, we still tried to produce a fairly good enough outcome, aware of the many limitations. Reader should also be aware of these and keep in mind the limitations of this work.

8.3 Further Research

After reading, analyzing, and coding the literature, it emerged that many people perceive VR usefulness in experiential learning as very promising. However, further research is needed. As the technology develops and people become more and more familiar with it, there is a need to experiment more in order to understand how it affects the way people learn. A tighter collaboration between learners and developers seems the most viable way to create engaging and performing software. Moreover, there need to be more studies, with larger group samples and in particular from different cohorts, as age is a determinant factor in how people familiarize and interact with technology.

Based on the limitations listed on the previous paragraph, this study suggests the following future researches. Future research ought to be conducted in the concrete developments of VR in education. Such studies could ultimately validate or nullify the findings of this thesis. Every case study is unique. The findings of this thesis might be unique in the sense that they strictly apply to the case study it covers. For this reason, it would be important to conduct future research on similar cases, and then compare those findings with the ones from this paper.

Evidence suggests that VR offers a powerful tool to education in general and experiential learning in particular. However, more studies are needed on how people learn. It is worth remembering that VR is only a technology, the use we make of it depends on us. Content production plays a key role as a big part of the educational experience depends on how virtual environments are conceived. (McFaul and FitzGerald 2019)

Alrehaili (2018) tested the users' knowledge on the subject before, immediately after, and one week following the use of the system. Moreover, in this study, different technologies were tested in different sample groups. This approach follows a sound logic and is therefore in the author's opinion recommendable whenever testing the added value of VR (or any other technology) and whether it is superior to existing and previously used technologies. The same idea is supported by Fakier and Den Berg (2019).

During the first interview with Kauer he stressed the importance that universities have in the future development and adoption of VR in higher education. Using his own words, he defined universities as anchors that define the route and the direction. And again, he continued, although many people might not like it, anchors are very much needed to limit the excesses that a merely market driven development might bring. On the other side are corporations that create content and hardware. These are like the big boats that drive innovation. Ultimately, the right balance between these two would bring the most desirable outcomes. Possibly more studies should focus on the relations between academia and business world and how these have implications on innovation.

But the most involved people, or better stakeholders, that need to have a say on the matter are final users. In this case teachers and students. Whereas teachers have the important role of deciding whether or not to introduce new tech into classrooms, students are the ones who evaluate and assess the real benefits of these new methods. More studies could be conducted on teachers' and students' perceptions of VR.

Another idea for a study could be a larger glance to the whole ecosystem, where the institutions of universities, corporations, teachers and students collaborate and unite their efforts to build the future of education. A closer look at this synergy, with the intent of making it stronger could really be beneficial for future generations.

9 SUMMARY

Immersive virtual reality is a very promising technology for experiential learning. The possibility to deliver any type of experience, whether realistic or unrealistic, opens a wide set of possibilities for anyone interested in education: from schools to professional trainers, from employers to public institutions. Undoubtfully the greatest advantage of VR is its ability to reproduce any experience unlimitedly at zero cost, excluding the initial cost for purchasing VR gear and software. Moreover, VR eliminates any risk of injuries for its users, as it can be used in safe environments like home, office or school. The perceived usefulness of VR is clear to anyone familiar enough to this technology. However, some barriers to large adoption remain. Costs are prohibitive, hardware is expensive and so is software development. However, when eventually VR goes mainstream, prices are expected to plunge. As VR reproduces virtually a real-world-like environment, navigating through it is intuitive and easy. Therefore, perceived ease of use is also high among those who tried the technology. Ultimately, the technology acceptance model proves that VR has the full potential to reach large adoption in the years to come, as some industry experts have been predicting.

Considering what already stated above, the usefulness of immersive virtual reality to deliver experiential learning is certain. In particular, the first step in Kolb's experiential circle is proven to be fulfilled. As hardware and software improve, VR experiences will become even more realistic, reaching eventually the level of accuracy from the real world.

Nevertheless, some drawbacks remain. A considerable number of users experiences VR sickness, the uncomfortable feeling of dizziness caused by wearing an HMD. This is one problem that developers surely need to address. Those people who feel sick after using VR are less likely to give it a second chance. Therefore, some technical solution needs to be adopted to make the whole VR experience more enjoyable and pleasant for everyone. Another issue that needs attention is the lack of content. More software development is required. For this, two possible solutions are possible. First, companies hire more programmers and train them to design graphically attractive and yet educationally valid virtual experiences, so that teachers and learners have a broader selection of contents to access. Second, firms develop some intuitive and easy to use platform where educators can design themselves the virtual environments, they consider best for their teaching purposes. Such software shall be designed with keeping in mind the less experienced user, who needs to design a good VR environment, but cannot spend weeks learning how to code or reading thousands of pages long manuals. Both of these suggestions have a substance managerial value for firms involved in VR business as they are capable of building profitable business models on either one of them. But before that, VR needs to reach broader audiences. People need to try VR headsets in the first place and if they are satisfied with what they experience they will decide to buy them. Again, the technology acceptance theory comes handy. Not only perceived usefulness and perceived ease of use matter. In fact, it still needs to be understood how people will actually use the devices. Smartphones are a very concrete example. Devices with the computing power of a laptop, that fit in a pocket, are used mostly to messaging and sharing content on social media. Although different, the case of VR headset shares some peculiarities with smartphones. Entertainment sells better than education. Hopefully we could learn something from this.

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