Immersive technologies between technicization and human dimension: general aspects and applications

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Abstract

Aim. The paper offers an overview of the most studied and used immersive technologies to date, considering the main applications and possible related experiments. In recent years, the technological revolution is profoundly changing humanity's way of life. Immersive Technologies, in particular Augmented Reality (AR) and Virtual Reality (VR), are changing the relationship between humans and technology.

Methods. Immersive technologies are introduced starting from a historical point of view, through a possible definition and concepts that describe in particular AR and VR, towards the recent developments.

Results. Industry, the entertainment sector, marketing, medicine, education and training are considered as main fields of application. Then the focus goes on the discipline of Public Speaking, considering its challenges, techniques and benefits.

Conclusions. The potential benefits of AR and VR in the considered application fields are highlighted, and a discussion of a study conducted at the University of Padova (Italy) relating to Public Speaking, are indicated. Negative aspects related to issues such as privacy and control are also highlighted.

Keywords: Reality, Immersive technologies, Augmented reality (AR), Virtual reality (VR), Public Speaking, E-methodology, Education, Privacy.

Introduction

In recent years the technological revolution is profoundly changing humanity's way of living, opening up new and unprecedented scenarios. Immersive Technologies, in particular AR and VR, are changing the relationship between humans and technology; the latter is no longer limited to the PC screen, but is

increasingly penetrating daily life, merging with it. This is a revolution that requires the creation of content for the countless applications that will be carried out in all sectors, including training and education.

The pillars of this technological revolution are Robotics and Artificial Intelligence, which, in their positive meaning, should lead human beings to improve the quality of their personal and working lives.

The concepts linked to the definition of Immersive Technologies are VR, AR, Immersion and Presence, fundamental in the creation of virtual environments and in the perception that human beings have of themselves.

It is instructive to provide a general overview of VR and AR, clarifying their characteristics and main differences. Among the fields of application of the indicated technologies, we have first and foremost the industrial sector, "Industry 4.0", which is bringing radical changes in production and logistics. The entertainment sector also stands out, understood not only in the recreational sense, but relating to tourism and sport . Immersive Technologies are producing considerable changes in communication and marketing, relating to the promotion of brands and sale of products and services.

Another key sector concerns the scientific world, in particular the medical field, both for the training of students and doctors and for the analysis of new techniques and therapies. The field of training is expanding from the educational point of view and in relation to specialised learning, for the creation of new stimuli and new content.

There are excellent situations for using Immersive Technologies in a very advantageous way, such as Public Speaking, linked to the ever-increasing interest by companies in the field of training, paving the way for new scenarios of possible development, such as the implementation of training that uses a VR viewer, with dedicated software, to improve Public Speaking skills in a simple, intuitive and accessible way at any place and time.

Immersive Technologies

Immersive Technologies are the pinnacle of a continuously growing path made up of technological innovations and changes in particular in the relationship between human beings and science (Man and technology, 2021).

These technologies, associated with graphic languages, are a fixed point in the video game and entertainment industry, but have recently been spreading in various other fields, including training, to support experiences that further improve the way to communicate.

From Robotics to Artificial Intelligence: The topic of "robotic servitude" has followed the philosophical debate regarding automatons since ancient times. The term "automaton" has Greek roots meaning "it who moves by itself" (Aristotle, 2007). The idea of creating devices to help and simplify everyday life has always been the subject of research by human beings, in particular for activities considered monotonous, tiring and which can probably be automated

with current technology (Kavanagh, Luxton-Reilly, Wuensche, & Plimmer, 2017).

The idea of building an artificial hybrid, equipped with movement and autonomy in its own actions, is therefore not of recent times, nor a direct consequence of the development of information technology and robotics.

In the Renaissance period, between the end of the Middle Ages and the beginning of the Modern Age, there was a real flourishing of studies and projects of mechanics and mechanisms, with great interest in the mobility of objects, as can be seen through the figures of illustrious inventors, such as Leonardo da Vinci (Leonardo3 Museum). The invention of the first steam engine in 1705, with subsequent improvements, initiated the creation of the first autonomous devices (Rosen, 2012).

Although in the ancient and recent past the aim of robotics was the attempt to create machines that could reproduce the behaviour of intelligent beings, this is currently accompanied by the objective of creating collaboration between robots and human beings.

The increase in production of factories and industries is progressively leading robots to increasingly replace the human labour, which should thus become available for other common jobs.

The robot has gradually entered people's homes as a synonym for small household appliances; the technological development of the twentieth century allowed the creation of the first prototypes of robots, starting from the mechanical arms used in industrial production lines, up to the most advanced humanoids created in the last twenty years (humanoid robots, exoskeletons, prostheses, industrial robots) (Makhataeva & Varol, 2020).

The automotive and electronics industries are making large investments in automation; globally, the industry is carefully considering the benefits of smart and connected manufacturing (Farinha, Pereira, & Almeida, 2024). Hand in hand with scientific discoveries in the mechanical and mechatronic fields, information technology has also rapidly spread since the 1970s, vital for the development of increasingly complex modern robots.

From artificial intelligence to immersive technologies: AI is one of the main innovations of recent decades; its birth cannot be directly traced back to robotics, but still refers to the founding models of the latter one. In the period between the 19th and 20th centuries there was a high development of studies in mathematical and logical fields, with the introduction and definition of the notion of a machine capable of carrying out in principle any algorithmic calculation.

Scientists realised that, assuming the theoretical existence of a machine capable of performing any type of algorithmic calculation, the possibility of conceiving the human thought as a sort of calculation would allow the creation of a mechanical device capable of thinking (Taylor, 2024).

Immersive technologies - immersion and presence: Since the 90s, scholars from various disciplines, including neuroscience and communication, started research projects linked to the virtual environment, in an attempt to give an appropriate scientific connotation on issues related to immersion and presence.

The term "Immersion" means the sensation of being immersed in a virtual environment thanks to the quality of the sensory information received during the experience. It is a sensation developed by the person's brain of "being elsewhere" compared to the reality in which she/he finds her/himself; it is all the better the more the used devices are able to reproduce realistic and credible images, sounds and sensations in real time (Slater, 2014). The "perfect immersion" is achieved when the technical quality becomes capable of reproducing entirely virtual scenarios with the same quality as real ones.

By "Presence" we mean the sensation of being involved in an environment regardless of its virtuality; it is an indicator of the level of involvement of the virtual experience, given by the sensation of being truly involved in the synthetic environment. This is a more subjective experience than immersion, which is understood as something relatively objective.

In VR, immersion and presence are linked; a virtual environment aims to replace the real one, then immersion is one of the components necessary to guarantee a good level of presence. Immersive Technologies refer to technological solutions that attempt to imitate the physical world through the means of a digital or simulated world, creating a sense of immersion for the person.

Technologies: the term "Immersive Technologies" involves a whole group of technological innovations including Augmented Reality (AR), Mixed Reality (MR), Virtual Reality (VR), 360° video and other immersive platforms (Arkhipova et al., 2024). These technologies aim to provide multisensory stimuli, such as visual, auditory, olfactory, kinesthetic ones. The ultimate goal is to make these inputs so realistic as to replicate the stimuli of the real world and make our sensory system believe that we are really experiencing that specific situation or experience, which in fact is purely virtual.

Considering the recent developments in AI and Machine Learning Technologies, immersive digital reality technologies are a candidate to be the next step in many marketing activities (Lowell & Yan, 2024). Even in the field of training, these tools can accelerate and improve the experiential learning; it is the "learning by doing".

Immersive Technologies include:

- VR: this is a three-dimensional scenario built on a computer, which replaces the user's physical environment;
- AR: it is an increase in the perception of the real world obtained by adding digital elements that overlap with the physical world;
- Holography: creation of three-dimensional images in space;
- Extended Reality (XR): the term refers to all combined technological solutions, real and virtual, and person-machine interactions generated by information technology for wearable devices (Rani, 2024).

Reality does not exist in an absolute, objective sense, it is a subjective concept. Each person lives her/his own reality and builds it on her/his own perceptions, experiences and emotions (Yazdi, 2024). Reality is a synonym of experience and individuality, it is subjectivity

On AR and VR

AR and VR technologies are often considered equal, but there are notable differences between them; the first provides textual, symbolic and graphic information that overlap creating a relationship with the surrounding world, the second instead is a complete creation of a new world (Aukstakalnis, 2016). Since the early 2000s, interest in AR has considerably grown, particularly with application prototypes especially in the gaming field (Singh, 2019; Raskar, Welch, & Fuchs, 1998).

About VR: VR is a technology that involves information technology, computer graphics and electronics, offering to users the illusion of being immersed in a virtual world with the ability to interact with it (Brooks, 1999). It is a three-dimensional virtual space simulated on a computer, which offers new ways of perception through the senses.

Seven different concepts describing VR have been identified: simulation, interaction, artificiality, immersion, telepresence, full-body immersion and network communication (Heim, 1994; Olshannikova, Ometov, Koucheryavy, & Olsson, 2015).

- Simulation: it is an increase in image quality, through computer graphics, such that it can be compared with the real world
- Interaction: the level of interaction between VR and user is very close to real world interactions.
- Artificiality: it is a concept relating to going outside of ourselves to try to look better, even from outside, than who we really are.
- Immersion: through immersion systems, the user completely immerses her/himself in a virtual dimension.
- Telepresence: it refers to the fact that the user can be in two worlds at the same time, the real one and the virtual one.
- Full body immersion: through the use of specific tools, such as gloves and particular special suits, the user is able to control a virtual form of her/his own body.
- Network communication: it allows sharing of multiple virtual worlds creating a new form of communication.

VR has been also classified into five categories:

- Desktop VR: it is a low-cost solution for VR, which uses a computer monitor as a display of a virtual world. Interaction occurs only via mouse or joystick.
- Fully immersive VR: the user has the feeling of being completely immersed in the virtual world; this is created using special devices and tracking systems for having a complete match between the user's movements and what she/he sees of her/himself in the virtual environment.
- CAVE (Cave Automatic Virtual Environment): it is a room whose walls are made up of screens onto which a computer-generated virtual world is projected. It is a particularly impressive technology for group experiences because several people share the same experience at the same time.

- Telepresence: this is a set of technologies that allow users to feel present and interact in a place where they are not physically present.
- AR: it is the direct superposition of virtual elements in the real world.

About AR: AR is an advanced technology based on VR that aims to create an enhanced view of reality through the use of computers. Contrary to VR, it does not necessarily require the creation of a realistic illusion; it can be considered as an extension of VR that mixes a view of the real world with virtual elements for creating a mixed reality (Martín-Gutiérrez, Efrén Mora, Añorbe-Díaz, & González-Marrero, 2017).

The main objective of AR is to influence perceptions, in particular vision and hearing, increasing them in terms of sensitivity and experience (Chen et al., 2019). AR is an enriched reality that modifies the basic scenario with the addition of animations and digital content that allow one to have a more in-depth knowledge of the surrounding environment. It can be considered as a medium, a mediation of ideas between humans and computers (Craig, 2013). The user can obtain additional information directly and immediately, experiencing what interests to her/him through her/his senses. An AR system is mainly formed by the combination of hardware and software components such as sensors, a processor, a display.

Fields of Application

Today Immersive Technologies are a constantly growing sector in information technology; research has developed solutions for multiple and differentiated sectors such as entertainment, industry, art, communication, education, navigation, tourism, medicine.

- *Industry*: VR and AR are an integral part of the digital industry of the future which sees continuous technological innovations such as Additive Manufacturing (i.e. 3D printing) (Colibrium Additive), the Internet of Things (i.e. the technology that allows objects, even those that do not have a digital nature, to connect to the Internet) (Internet of Things), AI, Nanotechnologies (Di Sia, 2014; Di Sia, 2017).

Existing examples and future projects concern vision systems and modeling software designed for mobile or wearable devices such as smartphones, tablets, displays, electronic glasses, retinal projectors. They can be interesting tools to improve productivity, reduce time and development errors, provide real-time analysis, a type of multi-sector technology connected to "Industry 4.0" (Di Sia, 2021a).

These are technologies for a substantial improvement in production, involving staff training, production, planning, assembly, workplace safety, digital prototyping, maintenance.

- *Logistics*: in this sector the use of Immersive Technologies macroscopically reduces the costs of storage operations. Emerging computer vision and ma-

chine learning solutions can identify where a product is and whether it is the correct product, faster than a human being can . AR mobile systems allow real-time object recognition, barcode reading and internal navigation (Liu et al., 2024).

- *Production*: in the production sector, the possible cases of use of AR are varied in relation to almost all activities that take place within the factories, from core production activities to support processes. It is possible to intervene in the production phases in a context of greater safety for personnel, monitoring all assembly and construction processes, with benefits in terms of productivity thanks to the simplification of workflows (Partarakis & Zabulis, 2024). The automotive sector benefits from MR in welding processes, in the planning of production lines, in the verification of various car parts and components, for safety and driving assistance through navigation systems.
- *Entertainment*: the entertainment sector is currently the one that uses AR and VR technology the most. Demand from businesses for video gaming, events and entertainment is constantly growing. VR is much more engaging from a video-game point of view, but the gaming sector is the strong point of AR (Hutson & Hutson, 2024).
- *Tourism and sports*: the AR entertainment system also includes the world of tourism such as installations in museums, tourist sites and entertainment centres; users can observe installations, art works, monuments and simultaneously view the relating information (implemented guides). With VR, users can immerse themselves in another historical era. AR and VR aim to improve also the player's customer experience.
- *Marketing*: AR and VR are having a huge impact on communication and digital marketing, generating enthusiasm and emotion, and providing high levels of involvement in the consumer's mind. The immersion in other worlds creates particular experiences and emotions in people, capturing the customer.
- *Medicine*: among the fields of application of VR in the medical field we remember the motor and cognitive rehabilitation, the therapy of psychiatric disorders and learning in a simulation context, contributing to a behavioural improvement of human health. There are also procedural and surgical simulations, offering wide-ranging training experiences without risks and ethical concerns. Students and doctors can precisely study the patient anatomy and future diseases and scenarios by visualising internal organs without having to open a human body (Li, 2024; Di Sia, 2021b). This type of technology is fast and efficient, and helps surgeons in saving time during emergency surgeries.

VR is used to treat anxiety disorders, phobias, eating disorders, post-traumatic stress disorders (PTSD) and addictions (Comeau & Cohen, 2019), with multiple advantages, primarily the accessibility to treatments. Instead of relying solely on imagining a particular scenario, the system is able to have the patient experience a safe and controlled scenario.

- *Education*: school educational institutions that use new Immersive Technologies, in the classroom or on educational trips, create completely different new learning opportunities for the children, in particular of the new generations, accustomed to acquiring knowledge by doing, experimenting and using a screen (Di Sia, 2022a).

Educational benefits: basically they are accessibility, availability, involvement, collaboration, immersion, universality. The parallel reality of AR offers multiple advantages in the educational sector:

- Accessibility: learning materials replaced by AR become accessible at any time and in any place, leading education to be more accessible and mobile.
- Availability: AR does not necessarily require expensive hardware, since its use can take place via smartphone, and this makes the technology available to many more users.
- Engaging: AR technology makes learning interactive, bringing it closer to playful experiences, and induces a positive impact on the student. Learning becomes thus more fun and less onerous
- Collaborative: AR apps offer various opportunities in terms of collaboration, thanks to interactive lessons; this increases the involvement of students in the learning process, helping to improve the teamwork skills.
- Immersive: students are more immersed in the subject, obtaining more lasting results and allowing them autonomy to explore.
- Universal: AR techniques enable learning on a global level, from kindergarten to university, up to on-the-job training (Kapoor, Pandey, & Rose, 2024). If well designed, it is an experience closer to a direct experience than educational television or educational visits.
- *Training*: Immersive Technologies and their applications are used to train qualified personnel in various production centers worldwide, stimulating significant productivity improvements and shortening the learning curve for personnel.

There are applications that provide remote calls, access to contextual documentation and resources, step-by-step guides to tasks. The training is brought directly into the field where it is applied to real work situations. Workers can see the precise methods for performing a task while they are performing it and, if necessary, specific instructions can be recalled on request. All this tends to reduce time and costs.

AR and VR are becoming increasingly important in the field of learning and knowledge construction, because they allow the design of learning paths based on the experience built by the user, in a learning environment in which to experience the training process as a moment of participation (To, Yu, Chung, & Chung, 2024).

Through Immersive Technologies, new virtual worlds can be created by implementing traditional training systems, without replacing them, but contributing to a better development of training techniques through experiential learning (Caratachea & Monty Jones, 2024).

This is a type of learning that is not limited to single age groups or educational levels, opening new scenarios capable of enabling effective, engaging, stimulating and dynamic immersive experiential teaching. There is a shift from a "teaching-listening" method to a more active and participatory study, in which users take responsibility for their own learning (Mintz & Litvak, 2001). Immersive virtual experiences foster a sense of presence and embodiment.

- *Negative aspects*: it is also necessary to consider some aspects that could hinder its diffusion; an excessive number of sensory inputs, due to immersion, would lead to cognitive overload, acting negatively on learning which would be diminished compared to traditional teaching methods.

The consequences of using VR in terms of health must also be considered. Some studies have detected problems related to what is called "cybersickness", i.e. symptoms of motion sickness due to immersion, with sensations of headache, nausea, disorientation and vision problems.

Given the high degree of immersion of VR, it is expected that in some people it may cause a sense of alienation and isolation. The virtual world could be more attractive than the real one, accentuating a detachment from reality, with a possible increase in the user's social isolation.

In a VR experience, the user is totally isolated from a sensorial point of view; she/he is unable to hear the noises of the real environment, nor to see what is really happening around her/him. Staying in a virtual environment for a long time could dissolve the perceptual boundary between reality and fiction, convincing the user to be able to do in reality what she/he easily does in the virtual environment.

Being regularly immersed in a virtual reality environment can lead some users to become desensitised to the real world. VR is used as a tool to emotionally induce individuals to overcome phobias and fears. However, outside of this therapist-controlled use, desensitisation can become a danger, leaving users insensitive to situations encountered in some VR environments, to the point of eliminating positive fears, i.e. those that help us to survive in real life.

- *Manipulation and privacy*: the evolution and growing diffusion of technology is leading Internet platforms to be increasingly VR-friendly, offering significant opportunities to companies that want to use it to promote their products and services. The virtual experience has a high emotional impact on people, managing to convey very effectively sales messages.

The experience is experienced as real, therefore the related effects could be fraudulently used, as they are simulations where the user is totally immersed and protagonist. This has undoubted consequences also in terms of privacy.

By using the Internet we are induced to disclose our personal information; carefully reading the conditions of use or privacy information is very time consuming, so people usually accept the conditions and continue browsing. More and more sites do not allow to proceed unless we first give consent to the data processing, as well as regarding the acceptance of cookies, which are a tracking

tool and offer dedicated advertising banners, without being able to do much to refuse them.

With VR it becomes even easier to convince people to provide information, by virtue of its characteristics, leading to possible unpleasant and invasive consequences, with scenarios of violation of the individual's fundamental freedoms, as happened in the world from 2020 to date (Di Sia, 2022b; Di Sia, 2025).

Commercial applications of VR environments introduce the possibility of targeted advertising, also called "neuromarketing", attacking the mental autonomy of the individual (Shiv et al., 2005). By tracking details of people's movements in VR, including eye movements, involuntary facial gestures, and other indicators called "motor intentions", private agencies can capture details about people's interests and preferences in totally new ways (Butterfill & Sinigaglia, 2014).

This can lead to an influence and manipulation by real-time feedback of motor intentions, for example through automatic and unconscious responses in the neuronal system (mirror neurons), resulting in a powerful unconscious influence on behaviour (Brozzo, 2017).

The art of Public Speaking

This is the art of oratory from ancient times to date, a technique that laid the roots for the discipline of Public Speaking, which also involves non-verbal communication (kinesics, gestures, facial expressions, eye contact, posture, proxemics, haptics) (van Eemeren, Grootendorst, & Grootendorst, 2004).

We can understand Public Speaking as an interactive communication activity carried out by a person who wants to present ideas or thoughts through a speech given in front of an audience (Baccarani & Bonfanti, 2015). This communicative act occurs in all aspects of daily life, from work to private life.

Communication is one of the fundamental bases of growth and development of every society; in this sense, the art of public speaking is understood as an indispensable and developable skill, which presents itself in all aspects of daily life. Effectively communicating is not an innate quality, but a professional need, comparable to speaking and writing correctly in the native language. Therefore, good training and lots of practice are needed (Carnegie & Esenwein, 2007).

Becoming an effective public speaker is an evolutionary process that requires continuous development and adaptation of skills for changing audiences in specific situations, and with society and time.

We can understand communication as the process of creating and sharing meaning in informal conversation, group interaction or public speaking (Verderber, Sellnow, & Verderber, 2015). The communication process must be supported by all tools that enhance communication itself and favour the achievement of objectives.

In an emotional message, 55% of the message is transmitted through the body language (gestures, facial expressions, postures), 38% by paraverbal aspects (tone, rhythm, timbre of voice), and 7% by pronounced words, that is, from

the verbal content (Mehrabian, 1972). The sum of non-verbal and paraverbal language constitutes 93% of the communicative act.

- *Non-verbal communication*: Non-verbal communication varies regardless of verbal one; these two forms of communication do not act separately, but work synergistically for providing a better understanding (Andersen, 1999). The audience to which the message is addressed is greatly influenced by the perceptions it has of the speaker; when a verbal message tends to contradict the non-verbal one, the public is led to believe more in what is said with the body rather than what is stated with words (Burgoon, Manusov, & Guerrero, 2021).
- *Kinesics*: Through gestures it is possible to convey the most sincere emotions, those least filtered by rational thought. The purpose of gestures is to highlight own message by bringing own thoughts and emotions into the minds and hearts of the audience (Understanding Body Language and Facial Expressions).

Man is able to reproduce an unlimited series of facial expressions that enhance the verbal message. Many of these expressions are involuntary, but others can be managed. Eye contact and posture are the first expression of communication and creation of a relationship with the public, having an important social function (Kinsey, 2008; Marquardt, 2015).

Volume, tone of voice, rhythm and pauses are the components of the paraverbal field which, combined with non-verbal language, appear to be an integral part of effective communication (Levasseur, Dean, & Pfaff, 2004).

- *Verbal communication*: Verbal language still remains the pivot of communication, as it represents its content. It proves the speaker's competence on the discussed topic, the originality and depth of her/his thought, the richness of her/his speech (McCroskey, 2006).

An experiment on VR applied to public speaking

An experiment conducted at the University of Padova (Italy) (Notaro, 2020) analyzed the use of VR as a training and practice tool in Public Speaking, as a new solution compared to common therapies for social phobias, in particular for Glossophobia, and to show how the use of this technology can also prove to be a valid training tool for new teaching scenarios.

13 students of both genders, of different nationalities and with an age range between 20 and 25 years were examined, who were asked to produce two speeches to be proposed in two different scenarios, the first in front of a real audience and the second in front of a virtual audience through the use of a VR device.

At the end of the speech addressed to the real audience, a survey was given to each person in the audience for evaluating the speaker's performance, regarding various aspects relating to the speaker's verbal and non-verbal behaviour and relating to the effectiveness of her/his speech.

An additional survey was provided to the audience in the speaker evaluation during the VR experience, to evaluate the speaker's performance. Furthermore, a questionnaire was administered to the speaker regarding her/his personal opinion on the VR experience.

Objective measurements were also carried out on the number of gestures and on some characteristics of the speakers' speech, such as the number of spoken words and the speed of speech.

To find an administration method such that the survey was anonymous, easily usable, and that allowed the results to be divided in chronological order, associating each response with each speaker, Google Forms was used (Google Forms), which allows to create surveys or quizzes shareable via link.

In addition to the subjective data collected through surveys and questionnaires, data on the linguistic characteristics of the speeches were also extrapolated to evaluate the performances of speakers in the two experiences with different types of audiences, real and virtual, separating the audio track from the video (Audio Converter online; Elan; IBM Watson Speech to Text; Praat: doing phonetics by computer). Data processing is covered in detail in (Notaro, 2020).

Discussion and results of the experiment

Regarding the results, the experience with VR changed the perception of the real audience in judging the speech; survey participants positively evaluated the speaker's use of VR.

An improvement was observed in the speakers, in particular in the vocal aspect, i.e. in the modulation, in the power of voice and in the correct use of pauses. Regarding the non-verbal aspects, an improvement in the physical presence and spontaneity of the talkers was observed. The aspect that remained unchanged in the two different experiences was the clarity of the message that the speaker wanted to convey with her/his speech.

Regarding the anxiety perceived by the speakers, the awareness that it was a fiction helped to mitigate the stage anxiety; the greater distance of the virtual audience compared to the real one made them feel more at ease.

The analysis of the collected data led to results that were at first sight uncertain. On the one hand, the subjective opinions of the public in evaluating the performances of the speakers suggest that in the experience with VR there was an improvement regarding both verbal and non-verbal aspects.

On the other hand, the same people in the role of speaker self-evaluated negatively their performance in the virtual environment, feeling more anxious and distracted by the excessive reactions of the virtual audience.

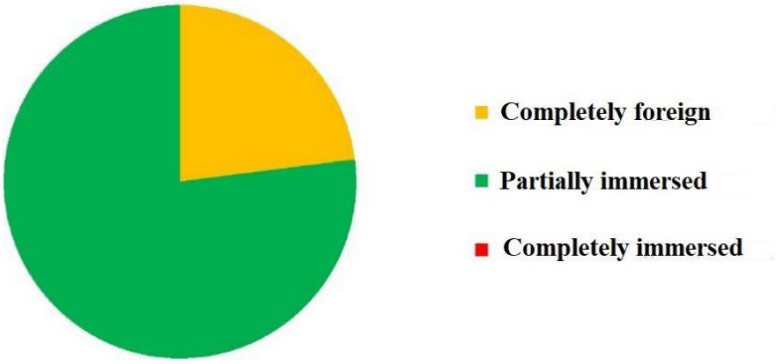

Figure 1
Immersion of speakers in VR
Source: own re-arrangement from (Notaro, 2020).

The data collected in the audio-visual analysis confirm this second hypothesis, i.e. that with the use of VR there is a tendency to make fewer gestures and more hesitations. Figures 1 and 2 summarise the main results.

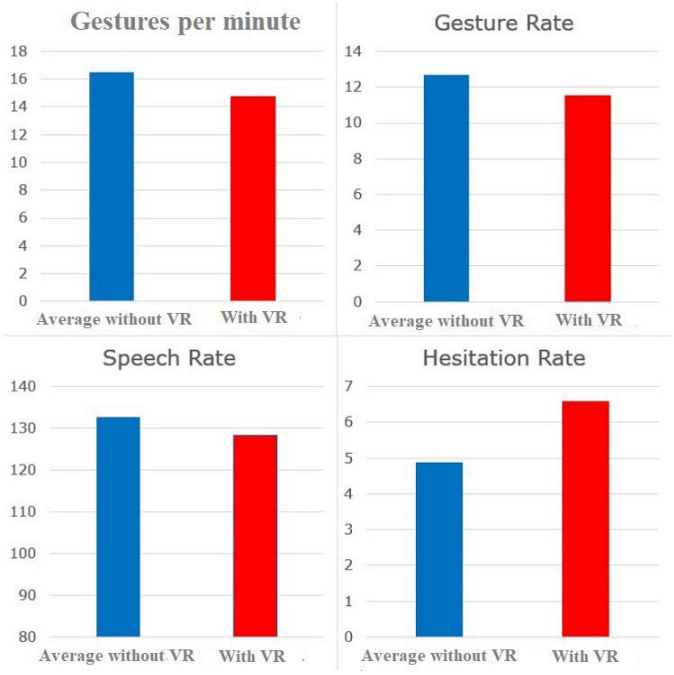

Figure 2
Overall averages of all students for each analyzed data.
Source: own re-arrangement from (Notaro, 2020).

Some observations could justify the obtained results:

- During the creation of the virtual experience it was realised that the virtual audience was in a distant position from the speaker, and presented characteristics much more similar to a video game than real representations of human beings.
- The appearance of the public influenced the effectiveness of the experiment, as it was represented through a computerised reconstruction of human characteristics, in fact not capable of competing with professional cinema or modern video game software. It was difficult for the speakers to feel totally immersed and therefore judged by an audience that they felt was not true.
- The reactions and animations of the characters that made up the virtual audience proved to be too accentuated, not showing the attitudes and reactions that a real audience would have had.
- The use of VR represented a sort of limiting barrier for the speaker; not observing a real reaction from the audience, she/he did not understand the progress of her/his own performance, resulting in a degradation of the latter one, due to insecurity.
- It is also necessary to keep in mind that this type of experience was based on the preparation, by the speakers, of two different speeches. If it had opted for a simple repetition of the same oration, an alteration of the results would have been introduced, dictated by the ease of repeating something already tried previously in front of a real audience.
- The fact that the speakers were not able to observe their own movements, as their vision was limited by the use of the VR viewer, pushed them towards a more thoughtful use of gestures, unlike the case with the real audience.
- The limited number of participants in the experiment certainly had a negative impact on a statistical level.

Conclusion

VR technology has emerged strongly on the scene in recent years and, in the relatively short future, it could have even greater diffusion and use. In the hopeful hypothesis of its use for truly useful purposes in society, it proves to have many positive aspects, but also critical issues relating in particular to privacy and personal freedom.

It is a technology capable of bringing competitive advantages in every area in which it is used, allowing reaching new horizons and progress that were previously unthinkable. Considering the sensation of presence that the user experiences when immersed in the VR environment, a modification of the learning process is evident with an increase in the potential for acquiring knowledge.

However, there are also negative aspects that the feeling of total immersion in a constructed reality could bring to the user. The possible abuse can be intentional and can lead to worrying and invasive problems, and negative effects.

In the near future, a further evolution of immersive technologies is imaginable, further bringing out their potential and also possible other critical issues. It is therefore appropriate and mandatory, as in the case of nanotechnologies, to seriously reflect on a regulation for this new technology, as well as on the type of use that users will make of it.

In relation to the experiment supported at the University of Padova (Italy), the subjective collected data demonstrate how the use of VR for Public Speaking can be a valid training tool; at the same time, however, the measurements showed a decrease in gestures by the speakers and an increase in hesitations.

Like all new technologies, VR applied to training, in particular to Public Speaking, also requires a minimum amount of time to adapt to the paradigm shift. The obtained results may also be influenced by the participants' first approach to this new technology

The expectation is that, in the near future, not only private individuals, but also companies, will be able to appreciate and understand the enormous potential of these technologies in the field of training.

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